Editorial

THE year 1951 has come and gone without leaving any considerable mark on events in the radio or broadcasting world. It was a year in which many things could have transpired, but for various reasons just didn't.

As anticipated, very little actually happened about television. Maybe the planning stage advanced somewhat, but I doubt whether we will see anything much in the way of programs during the next twelve months.

As we have already suggested, it is possible that the Government will proceed with one experimental station in Sydney, and maybe another in Melbourne, but I do not expect regular services to the public to take place for some time to come.

The reasons are almost entirely economic, and are bound up with the world situation which, although not perhaps as depressing as it was a year ago, still holds possibilities of big trouble on economic and technical grounds.

While the Government maintains its financial policy, particularly in restriction of credit, it is hard to see how it can also approve of television, which would involve the use of credits freely both by the public and the industry. It looks something of a stalemate between those who think we can't afford to have television, and those who think we can't afford not to. What transpires this year will depend almost entirely on the outcome, but I doubt whether we could do more than make a start on television in 1952..

Once again, microgroove records are billed for pride of place. I would be most surprised if we do not see EMI begin to make them probably in both 33 and 45 rpm speeds. In fact the impact of these records is quite likely to be even greater in 1952 than we imagine at present. There is a very big market ready for them.

Several other new developments are likely to be important during this year, but not all affecting the public directly. The transistor, about which you will read elsewhere in this issue, is creating great excitement in the electronic field. Pulse modulation is bound to make big strides in the control and communication fields, even though much of it will probably occur under cover. Miniature valves are likely to strike a final blow in replacing the larger types in more and more equipment.

It does not seem likely that radio sets will change very much in circuitry, although the radiogram should continue to build on its growing popularity. We will be able to thank microgroove records largely for that. Lots of prospective buyers haven't even heard of them yet. But they will.

Generally speaking, I think the prospect is brighter today than it was at the beginning of 1951. We still have plenty of doubts and dangers, but maybe these will become more and more part of our normal lives from now on. At present we are building up entirely necessary resistance to these things. When we have done this, and provided we are able to keep peace in the world, we will come eventually to a more balanced existence, with more time and money for those things which for the present we must be prepared to do without.

Let's hope this will be soon. It would make 1952 truly a Happy New Year!

John Moyle

RADIO AND HOBBIES IN AUSTRALIA

A NATIONAL MAGAZINE OF RADIO, HOBBIES AND POPULAR SCIENCE

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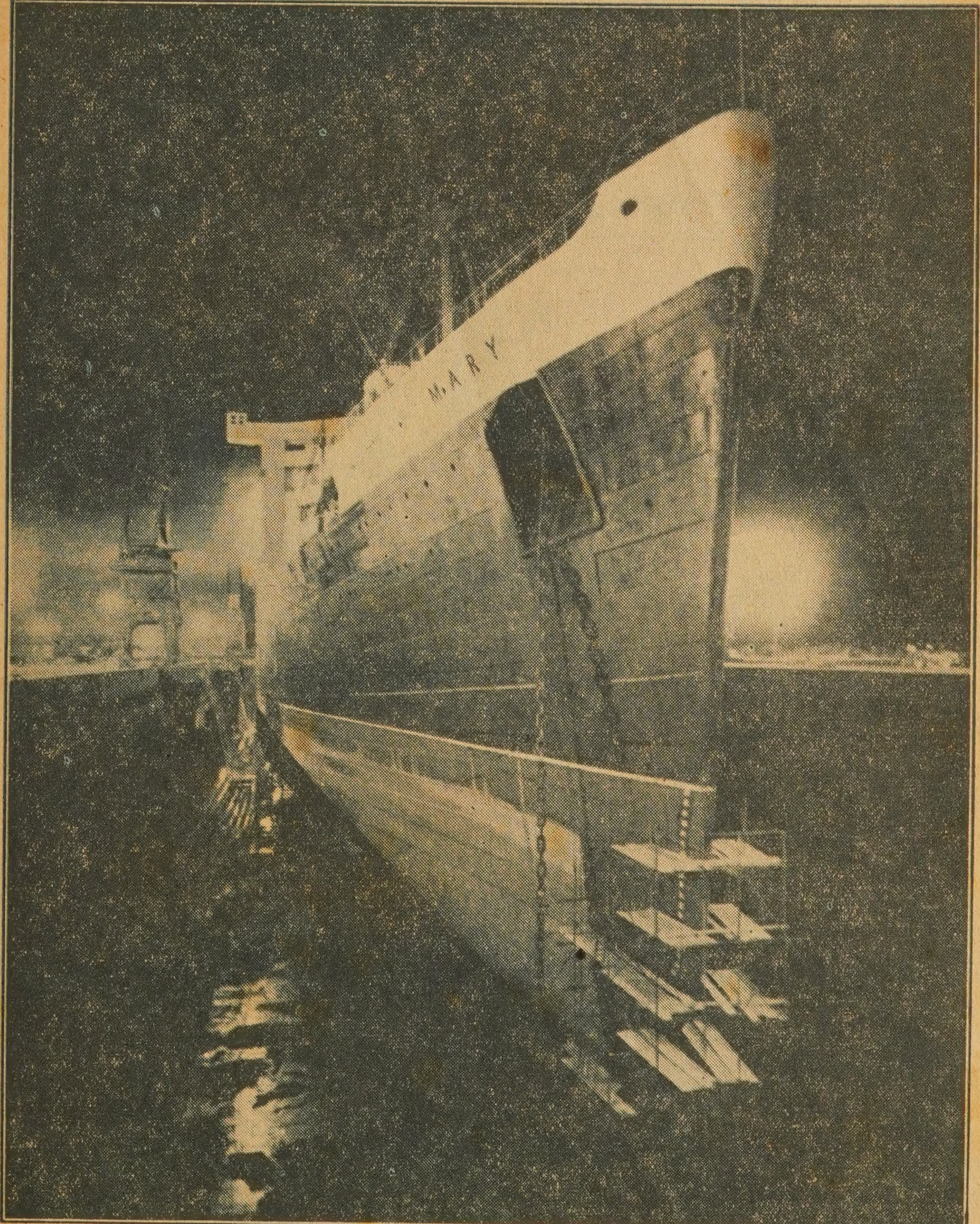
Phone BO333

OUR COVER PICTURE

Just to demonstrate that we do think of things other than radio, this fine picture shows how we hope every reader spent his holidays. But don't break a neck trying to emulate this one!

INDEX

MIGHTY JOB FOR THE CLEANERS!



LIGHT ON A LEVIATHAN—Ablaze with light from her elegant prow to as far back along her immense hull as the eye can see is the Cunard Liner Queen Mary, her brilliance accentuated by the night sky as she lies in dry dock at Southampton. She is undergoing her annual winter overhaul. Her 81,235 tonnage is still second only to the Queen Elizabeth, and still well ahead of America's latest—the United States of 51,500.

BRITISH HELICOPTER WILL SAVE

A general view of the Bristol Sycamore MK10 (ambulance version) showing side blister through which stretchers pass.

The growth of the helicopter has been rapid since the close of the last war. These strange "wawkus birds" are now part and parcel of every fighting force, and are finding more and more uses in civil life.

SO far this type of aircraft has not developed any great speed, nor is it adapted to it. To date, also, its load capacity isn't great. But with these limitations in mind, there are a host of instances in which helicopters are invaluable, and any new advancement or version makes the news.

Australians have only recently seen helicopters in the air. Occasionally during the war an American machine would be seen, but not long ago the RAAF added a number to its strength. These have taken the air in a number of displays in recent months, and have made many flights over capital cities.

The RAAF has general-purpose machines and uses them for training in air-sea rescue particularly.

In Britain, the Bristol company has released details of the Sycamore 10, an ambulance version of the type 171 single-rotor helicopter recently placed on the "open" list.

Specially designed for air ambulance work and general communications operations, this version of Type 171 is now undergoing an intensive Ministry of Supply test schedule at Boscombe Down.

The aircraft has been demonstrated to high-rank RAF officers at Moreton-in-Marsh, and more recently undertook casualty evacuation in the Army exercise "Surprise Packet."

MODIFICATIONS

Extensive modifications have been carried out to enable the aircraft to accommodate two GS stretchers, which are carried one above the other athwart the machine.

To house the stretchers, two large perspex blisters have been incorporated, one on each side of the fuselage. They are detachable and can be replaced by ordinary faired units when the aircraft flies in a normal communications role.

The Type 171's normal sliding doors, which would be rendered inoperative by blisters, are replaced by hinged doors which may be jettisoned if necessary.

The lower stretcher is supported by a metal structure which can be folded back as necessary to provide three normal passenger seats. The upper stretcher is supported by bars normally housed in a vertical position alongside the engine bulkhead. When needed they can be swiftly swung into position and made firm with a quick-release pin. Both stretchers are secured by clamp mechanisms.

The engine bulkhead also carries a housing for bottles of plasma and a plug socket for electrically-heated blankets for use in cases of exposure or shock.

In the air ambulance role the aircraft carries a medical attendant who sits beside the pilot. His chair is of the swivel type to enable him to attend casualties during flight. To give him complete freedom of movement the back of the pilot's seat has been reduced in height.

In the normal communications role, the attendant's chair and the rear accommodation provide seats for four passengers.

LIVES IN AIR AMBULANCE WORK

Design of the Type 171 has been influenced by considerations of safety and long life. Among many safety features is the use of a main rotor with a comparatively high moment of inertia and capable of running at high rpm. By this means, sufficient kinetic energy is produced to ensure a safe and comfortable landing in emergency.

Use of a high rotor speed also reduces the undesirable vibration features common to most helicopters, enabling the Type 171 to fly at more than 100 mph with maximum passenger comfort.

"BAG" FUEL TANK

All moving parts of the Type 171 have an estimated minimum life of 7500 flying hours, and the main structure of the fuselage is designed to withstand the worst out-of-balance forces which might be imposed by a damaged rotor.

Fuel is carried in a crashproof "bag" type tank aft of the engine and well away from the cockpit.

The Mark 3, now in production, has an Alvis Leonides LE23 HMV engine of 550 hp, and nose and cabin layout have been considerably improved. The engine is mounted with crankshaft vertical.

ESTIMATED PERFORMANCE

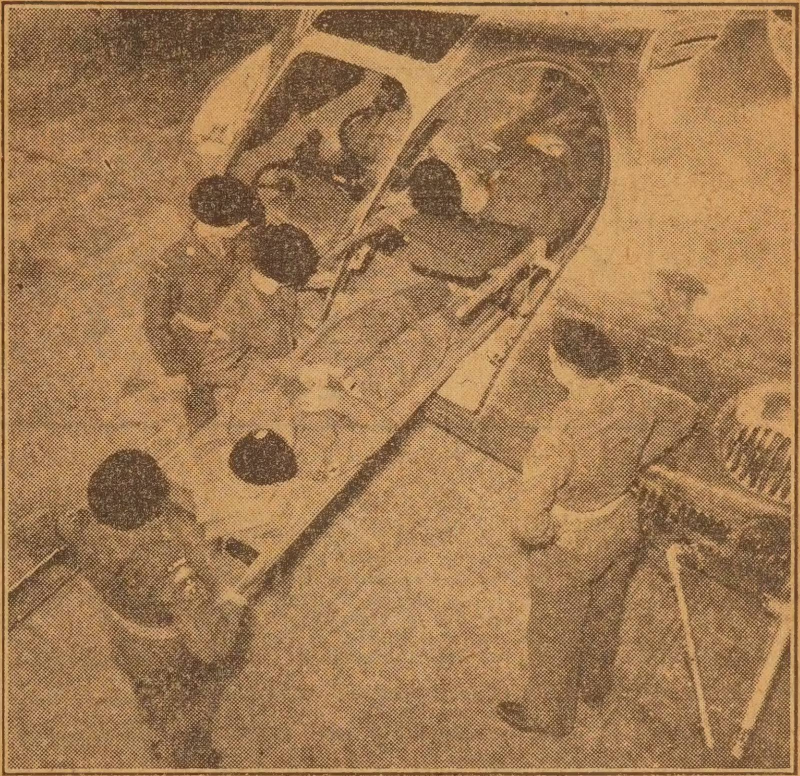
(I.C.A.N. CONDITIONS)

Service ceiling, 19,000ft.
Hovering ceiling (without ground cushion), 7900ft.
Max. speed, 5min rating, 133 mph at 287 rotor rpm.
Max. speed, 1hr rating, 121 mph at 268 rotor rpm.
Max. rich mixture cruising speed, 107 mph at 251 rotor rpm.
Max. weak mixture cruising speed, 93 mph at 242 rotor rpm.
Max. vertical rate of climb, 930ft-min.
Max. climb at forward speed (1hr rating), 1142ft/min. at 60 mph EAS.
Condition for max. still air range, 87 mph at 242 rotor rpm.
Condition for max. endurance, 55 mph at 242 rotor rpm.
Consumption for max. range condition, 5.2 mpg.
Max. still air range at normal load (60gal fuel), 310m.
Max. endurance at normal load (60gal fuel), 4½hr.

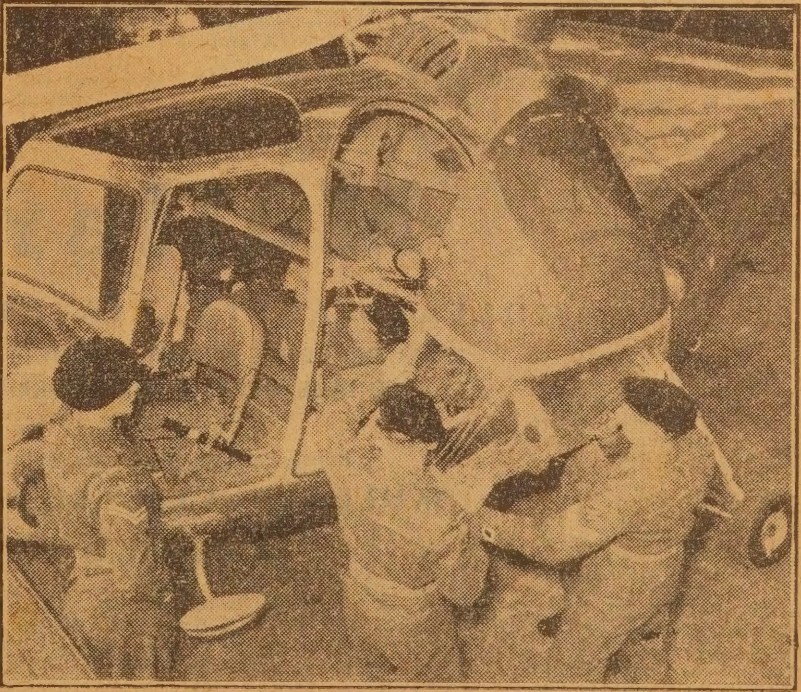
FAST WORK

In September, 1948, a type 171 helicopter took part in the demonstration known as "Operation Hare and Tortoise," planned to demonstrate the potentialities of the helicopter. A Type 171 was flown to a bombed site car-park near St. Paul's, where it picked up a letter from the Lord Mayor of London to the president of the Municipality of Paris. Flying to Biggin Hill, the pilot of the 171 handed the letter to the pilot of a Meteor, who in turn delivered it to another helicopter pilot at Orly airport on the outskirts of Paris. Within 47 minutes the letter had been delivered from the centre of London to the centre of Paris.

In April, 1949, the Type 171 completed another notable flight, when it became the first British-designed helicopter to fly the Channel.



Two stretchers fit behind the pilot and are loaded from the side by RAMC personnel during tests.



With the casualties safely aboard, the perspex blisters are replaced ready for flight.

SOME FACTS ABOUT HYDROGENATION

Few people bother to recollect that nearly everything they have for their personal health, comfort and amusement is the direct result of invention and scientific research, but it is by the very domestic manner in which hydrogenation can be used that everyone must know about a miracle which ranks with radio in industrial importance.

by Professor A. M. Low

THE word hydrogenation is perhaps a little unfortunate, although it is not nearly as complicated as it sounds. Hydrogenation means, not the reconstruction of the infinitesimal particles which form the atom, but the far more practical scheme of rearranging the larger molecules from which the initial atoms are themselves made.

Quite a number of examples of such a process are provided by nature, and if it were not for the extraordinary length of time necessary for their accomplishment in the history of geology all the resulting materials would seem fantastically impossible.

It is by an incredibly slow process of disintegration, as applied to trees and similar life from the earth, that coal has eventually been produced through changes which are now partially understood under the title of colloidal, or biochemistry. It was probably seaweed which began this cycle when its patience enabled it to grow roots and live upon land.

WEALTH OF COAL

In Great Britain the wealth of coal which was originally responsible for the industrial success of the whole country is mainly due to these changes which take place in the living matter made up of carbon, oxygen and hydrogen. Coal itself approaches pure carbon in some of its harder forms, but there are quite a number of varieties in which the nature of the product itself depends entirely upon local conditions, and the time taken for the metamorphosis.

There are other similar cases of so-called elements which, basically the same from the chemical standpoint, are quite different in physical make-up. Carbon can be found in the form of graphite or diamond. Sulphur has also a number of formations known as allotropic, all of which are produced by various circumstances of temperature and pressure.

These are really examples of some of the changes which can be made in the structure of matter, but the case of hydrogenation is different in that the alteration to the original substance is caused by the addition of hydrogen to the base which already contains a portion of this element.

It is believed by many people that the hydrogenation of pure carbon is a consequence of direct pressure changes carried on through millions of years, but it is probable that the action of sun upon seaweed deposited on land is a contributory cause. The net result is quite simple, for hydrogen has been added to the carbon to result in various hydrocarbons such as paraffin, tar and the innumerable aniline dyes and derivatives with which everyone is familiar.

If hydrogen could be added to any substance as required, without waiting for the processes of nature, there would be no difficulty at all in producing laboratory oil, which would otherwise take many million years to form in the earth.

As is well known, the gas itself can be combined with oxygen to form water, but the hydrogen can only be structurally added to substances which are weak in these elements and, therefore, anxious to obtain a larger supply from natural affinity.

It is nearly a century since the effects of hydrogenation were first discovered, but until the first Great War made its application necessary for the manufacture of nitrates very little practical success was achieved.

As the result of modern experimentation it is now very probable that the principles developed by Dr. Bergius may ultimately provide us with cheaper foods, better methods of lubrication, and perhaps a motor car fuel which would combine the conditions of clean petrol with the anti-detonation value of benzole. Even today the value of solid coal fuel is far less than its own by-products, and it seems quite possible that before long coal will never be used in its present wasteful form.

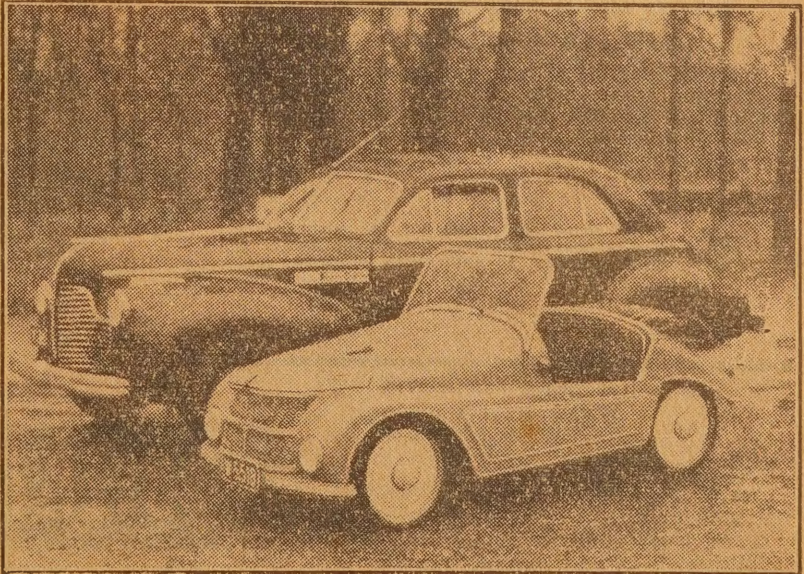
A great industry has sprung up around hydrogenation and, as it has been discovered that hydrogen can be attached to carbon itself by comparatively simple physical methods, it is more than likely that coal will become the source of various oils which together could make up the most important fuel civilisation has ever known.

There seems little reason to doubt that industry in this country may receive a new lease of life for, if our coal resources can result in cheap home-produced oil, it will justify the ranking of this discovery with such epoch-making inventions as the x-ray, the aeroplane or the internal-combustion engine.

The application of this rebuilding chemical process to many of the

(Continued on Page 9)

SMALLEST CAR IN THE WORLD



Reported to be the smallest car in the world, this little car made its bow recently in Vienna. It is only 8ft 7in long and 3ft 9½in across, and is powered with a 5hp engine. It has a speed of 44mph, weighs about 3½cwt and has a fuel consumption of nearly 100mpg.

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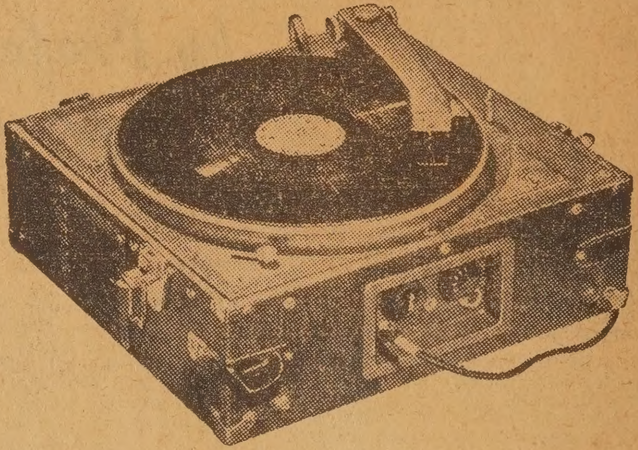

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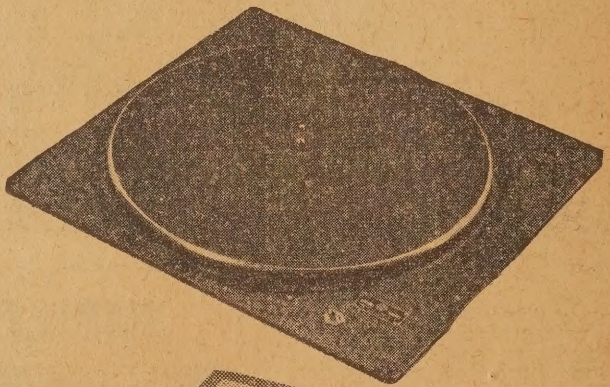

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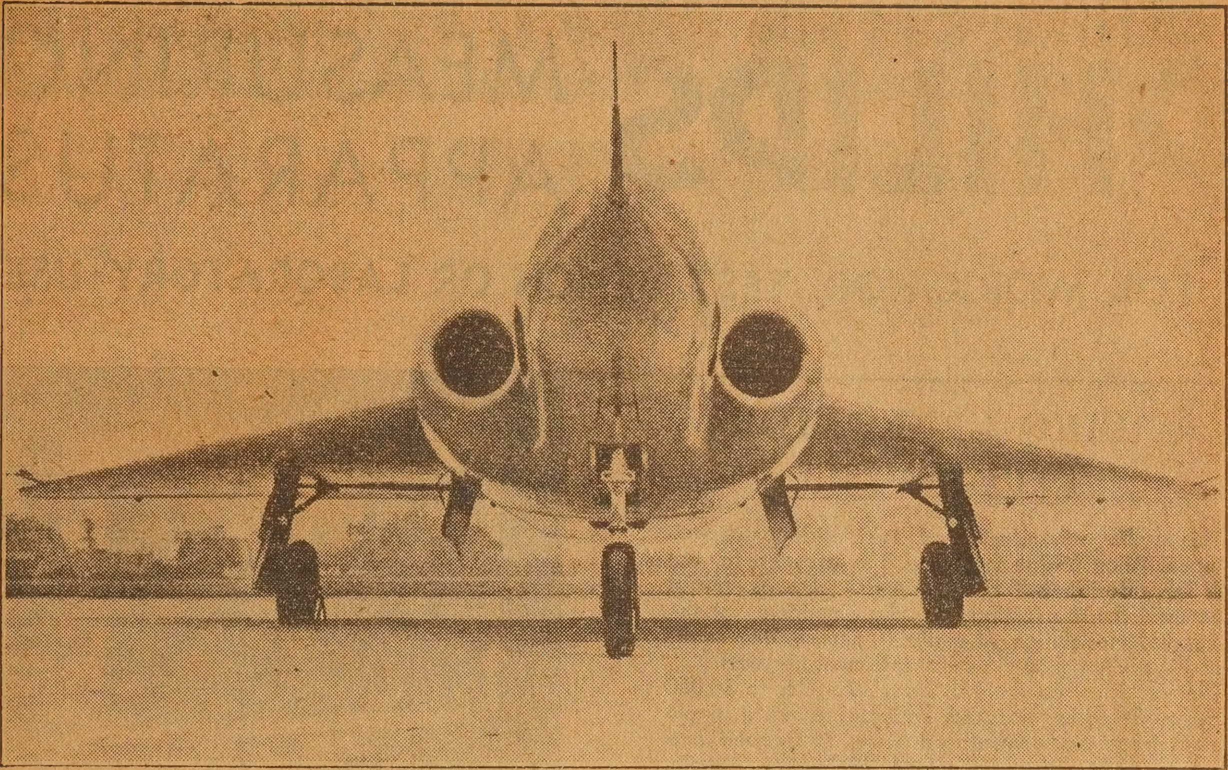
TWIN TRIANGLE FIGHTER OFF SECRET LIST



Britain's first operational, twin-engined "flying triangle" fighter, the Gloster GA5, is now off the secret list. The all-weather, day and night, long range fighter, produced by the Hawker Siddeley group, is powered by two Armstrong Siddeley jet Sapphires (claimed to be the world's most powerful). Speed, armament and radar equipment are still secret. The new Delta was first flown in November.

SOME FACTS ABOUT HYDROGENATION

(Continued from Page 7)

common substances of everyday life is even more striking. Cotton-seed oil can be hydrogenated or hardened to a fatty material with the consistency of lard.

Great success has resulted from experiments upon whale and herring oil, both of which have had hydrogen added to their formation, with the result that the final product loses all resemblance to the initial fishy base. All these oils have been used in place of cocoa butter for domestic purposes.

It is believed by many people, from preliminary tests, that sugar will eventually be reconstructed from sawdust, while such important natural solvents as turpentine can be made in synthetic form, or hardened and used with the by-products of fish in the manufacture of toilet soap.

The process itself which is responsible for all these seeming miracles is comparatively simple. It is accomplished in the main by the aid of high pressure and temperature changes in the presence of what is known as "catalyst." There are a number of substances known to science which are able to assist in the breaking up of molecular stability in some electrical fashion. These bodies are called catalysts because, although accelerating changes in other materials, they do not themselves suffer any alteration during the action.

A colloquial example is that of a bridge which allows the atoms and molecules of certain chemicals to pass over it, forming other chemicals on the opposite side of the bridge, but not affecting the structure of the road over which the transition takes place. One of the most used of all catalysts is a derivative of nickel, which is now replacing the original so-called oxide of iron in the industry of hydrogenation, and in particular its application to the preparation of lubricants.

HYDROGENATION LUBRICANTS

In the running of any internal-combustion engine one of the most important factors for the maintenance of efficiency is the type of lubrication employed. Unfortunately, the engineer is faced by a great difficulty, for no ordinary test can indicate the complete stability, or otherwise, of an oil for each one of the duties it is supposed to perform.

The ability of an oil to withstand high temperature without losing body, the lasting effect of its particles, the rate or pressure at which it will flow, resistance to carbonisation, and even the type of carbon formed in the engine, are all factors which can only be proved by long and costly experiments. In most common examples, lubricants are divisible into three chief classes: Vegetable oil, which is successfully used for racing, but which sometimes causes severe difficulties in starting and carbon deposition; the naphtha oils derived from coal products; and the ordinary mineral lubricants distilled from paraffinic material.

Other types which are commonly blended for general use very naturally combine the disadvantages as well as the advantages of both products.

It is not generally realised that a modern small engine often subjects an oil to far greater stresses than the large type of motor, which is only expected to run at full power for short periods. Small cars, for example, are fitted with high-speed engines working at a temperature and rate of stress reversal which demands an entirely different type of lubrication to that applied to any other machine.

In spite of these difficulties very little change has taken place in commercial lubricants, and most oils can only satisfy very few of the general requirements. Naphthalic products are reasonably satisfactory in regard to carbon deposit, but may fail in viscosity at high temperature, whereas the paraffinic class maintains body and can be poor as far as carbonisation is concerned.

It is this very difficulty of preparing a suitable oil by blending which has been partly solved by hydrogenation, for the original oils are subjected to enormous pressures in

(Continued on Page 13)

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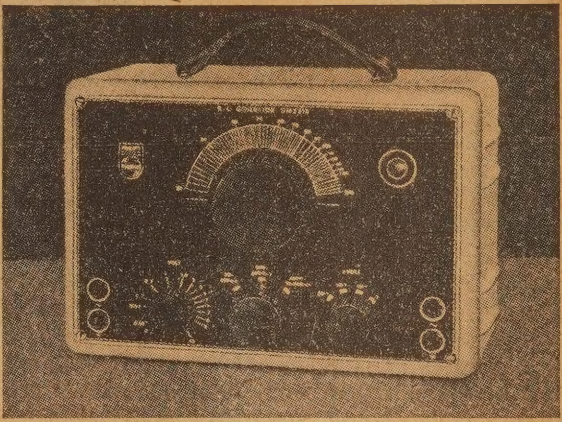

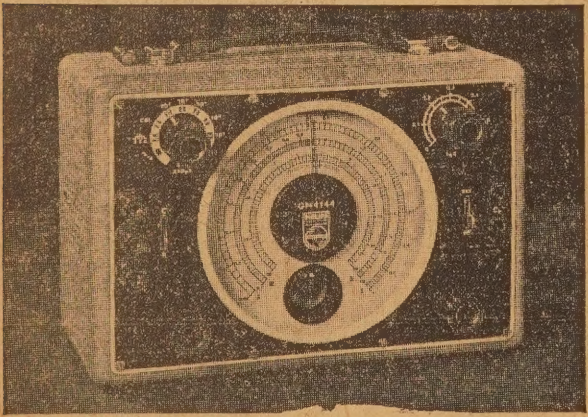

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Model GM4144 is highly suitable for all types of applications. The well spread scale, comparable with that of a Bandspread dial of a radio receiver, makes this unit far superior to most other bridges. Here are a few of the many possibilities and advantages of the GM4144. A. Measuring of condensers, resistors, electrolytic condensers and testing the insulation resistance of condensers. B. Large, well spread scales for direct-reading and for reading deviations in percentages. C. Reforming voltages for electrolytic condensers. D. Comparative inductance measuring.

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PHILIPS

ZWORYKIN TALKS ON TELEVISION

"We saw television as luxury entertainment," said Dr. Vladimir Zworykin, famous RCA electronic scientist at his first Press conference in Australia, "but instead it has become a poor man's entertainment. We had no idea, when television was in its infancy, that it would have such a wide acceptance and influence on the life of the people."

BY THE EDITOR

DR. ZWORYKIN, who visited Australia last month on a business-honeymoon trip, is an amiable, shrewd, obviously brilliant man, whose speech still shows profound influence of his Russian birth. So that if those were not his exact words, that is what he meant.

Zworykin has been in the television game almost from its birth. The growth of television as mere entertainment is something of recent origin, he says.

In the pioneer days, television was considered as a man-made eye, which could be taken where no man could go—a means to provide him with vision from afar off.

MANY USES

Just how many ways one could imagine using such a marvellous thing was the measure of the early conceptions of television. The truth of Zworykin's estimate is shown in his present television outlook. He is obviously far more interested in using his company's latest equipment to project magnified images of wogs in water than he is about Milton Berle and his funny faces.

When asked what he thought of American television programs—whether he wasn't sorry about his part in bringing them into being—he said he had too much "homework" to look very often at television. One or two programs he named as being not bad, but there the matter was finished.

To Zworykin, television, as the public knows it, is a rather obvious use of a modern miracle. Apart from improving equipment, he sees for it merely the extension of a service which is already realised. Even the development of color is to him an electronic challenge. I'll wager he is much more enthusiastic about its value in televising surgical operations than supplying the exact hue of a ball-gown.

ELECTRONIC SCIENTIST

For Zworykin, although his name is associated with the first patents on the iconoscope upon which the modern television camera is based, is primarily an electronic scientist. The world is told on comparatively few occasions about his work with Hillyard and others of his team on the electron microscope, and only vaguely understands what that means when it is. Even harder to explain is his use of electronic computing for such things as weather predictions, to allow swift calculations from known data and experience before the urgency has passed.

Dr. Vladimir Zworykin, vice-president and technical head of RCA's research centre with the display unit of his Vidicon television camera.

Much of his activity cannot be told because it is involved with secret defence projects. But it isn't a secret that he could probably tell his own little bit of history about the development of guided missiles which, together with the atomic warhead make up the most devastating weapon the world has known.

Nor do I think he would enjoy that aspect of his work nearly as much as the application of electronics to peaceful research, the investigation of the unknown, and the adding to man's store of knowldege.

The talks he has had with societies and individuals on a wide range of scientific subjects is the only evidence required of his catholic mind, of his mental inter-relation of the arts and sciences.

About the iconoscope and its successors he is animated and eloquent. To a questioner about it, he replied in a 15-minute non-stop explanation of how it works, how it was developed, and what he thought it could do. Maybe it isn't the first time he has performed the feat, but I for one enjoyed every word. For my less technical journalistic brethren I cannot speak. To Dr. Zworykin's credit, most of them were with him for at least half the distance.

LECTURE

He was even more interesting and explicit during his succeeding lecture given at the Wallace Theatre at the University of Sydney. Here, with the aid of slides, he gave a graphic picture of television history in the USA, and his company's part in it.

His lecture ended with an outline of the amazingly ingenious RCA color system, and when a couple of

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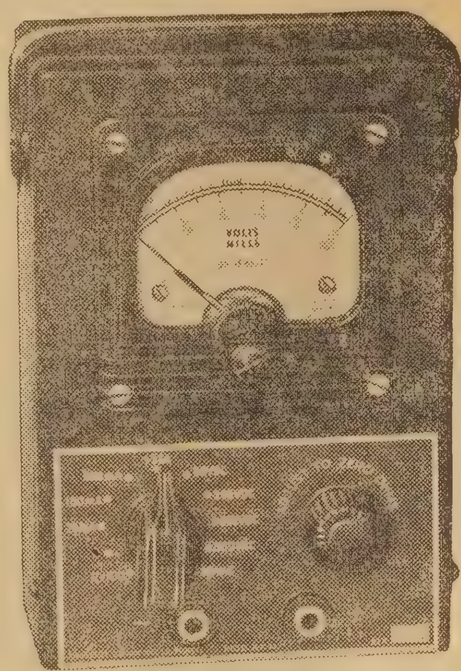

Like all other University equipment it is strong and ruggedly constructed and yet it is finely and accurately made. It will give you years of lasting service and efficiency. The case is of strong light steel finished in black brocade and a plastic carrying handle is fitted. It uses the new square University Model S3 Meter with Multi-Scale. With every Instrument, Test Leads and Instruction Booklet are supplied.

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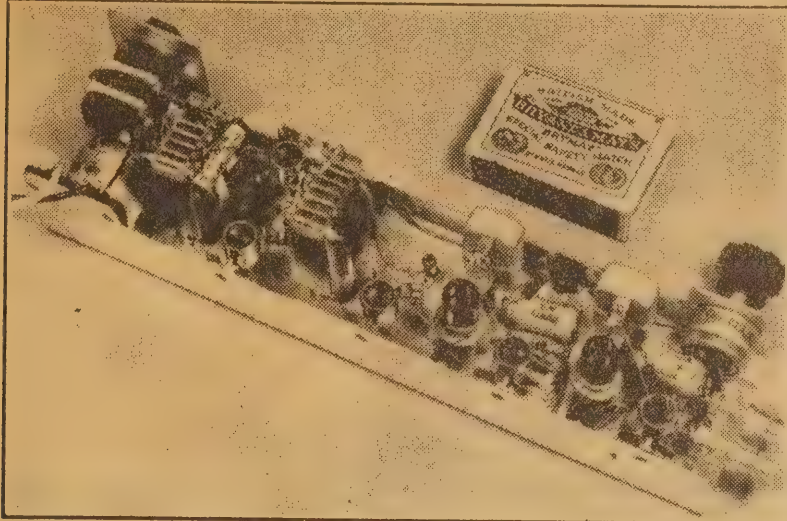


An English receiver using germanium crystal triodes developed from chimney dust by the GEC. The crystal valve and devices of its type are expected by Dr. Zworykin to greatly simplify television and electronic design.

color slides were shown at the end, photographed from one of his tubes, there was quite a remarkable and spontaneous burst of applause. The prima donna of the evening accepted it with appropriate dignity.

The matter of color television rouses mixed feelings in his mind, and, remembering the uproar over color which has only recently subsided with the FCC's suspension of all color activity, one can understand this. He frankly does not accept the FCC's explanation that the USA cannot afford to spend money on color until the world situation improves. He thinks that is a most convenient excuse to abandon the vexed decision made earlier to allow the CBS mechanical system of color in the States.

Again, no one can blame him, whether his ideas are right or wrong. He has never had faith in mechanical methods—he is an electronic scientist, and will never willingly use a motor when an electron will do. He knew Baird, and respected him, but more than that he would not say. He cannot assume any sympathy with Baird's ideas of revolving discs, any more than he can speak seriously of the CBS color disc, which has so much in common with Baird's early efforts.

LAWRENCE TUBE

I asked him to say something about Dr. Lawrence's new color tube which created something more than a mild breeze a few months ago. Any man of Lawrence's qualifications must be treated with respect, said Zworykin, and even to make such a tube in a backyard garage was no mean feat. But RCA had trodden the same path some years ago, and had discarded Lawrence's approach. There was even a broad hint that RCA patents could contribute independently to the story. "I can only say that we discarded the idea," said Zworykin, "and believe that no device today is better than the RCA color tube."

But he agrees with his chief, David Sarnoff, that color is still too far off to figure in immediate plans for television. All he asks is that any television system adopted anywhere should be of a type which is compatible with an approved color system.

He doesn't think that black and white will necessarily be abandoned for color, any more than in the film industry. In fact, this was one of the few matters concerning Australian television in which he allowed himself to be drawn. Just as 525 lines was the logical choice for America with 60 cycle mains voltage, he said, so 625 lines was the choice for Australia with 50-cycle mains.

MORE LINES

Despite the work done in Europe with more lines, he doesn't think they are worth wasting extra bandwidth to obtain. He thinks that before we are done, channels will be more precious than gold, and should not be wasted on gilding the lily, once an optimum standard has been reached. But without compatibility any system must fail.

Easily the most interesting thing Zworykin brought with him was a sample of the RCA Vidicon television camera—an insignificant looking thing about as big as a large movie camera, but which is capable of producing clear television pictures when operated with a control unit about the size of a table radio. This vidicon tube—a mighty midget—uses a once abandoned principle of photoconductivity, and, in this version, does its job with about half the valves required for larger cameras.

Its perforance, while inferior to the most modern types of camera used for television services, is quite adequate for many commercial uses. One of these was demonstrated in the Wallace Theatre, where the camera was mounted over a powerful microscope, using its optical system to throw an image on the screen of the camera tube. The televised picture of minute life in a drop of liquid was clearly visible to almost the entire audience.

Zworykin doesn't think that modern television equipment is complicated, despite the array of valves used

(Continued on Page 23)

SOME FACTS ABOUT HYDROGENATION

(Continued from Page 9)

specially prepared steel containers at a temperature which compares with that of the working conditions of an actual engine.

In the presence of hydrogen and the catalyst, the oils actually break down, and, as the hydrogen is added to their content, they form into a lubricant which is very much more stable, and in which some of the destruction by heat and pressure has already taken place in the retorts instead of in the engine during use.

These new oils can quite easily be built up in various grades, and are so stable that wear, due to formation of dirt, combination with water and other disadvantages, is almost entirely avoided, while it is claimed that the hydrogenated oil not only combines viscosity maintenance with the non-burning qualities of natural oil, but is also able to reduce friction.

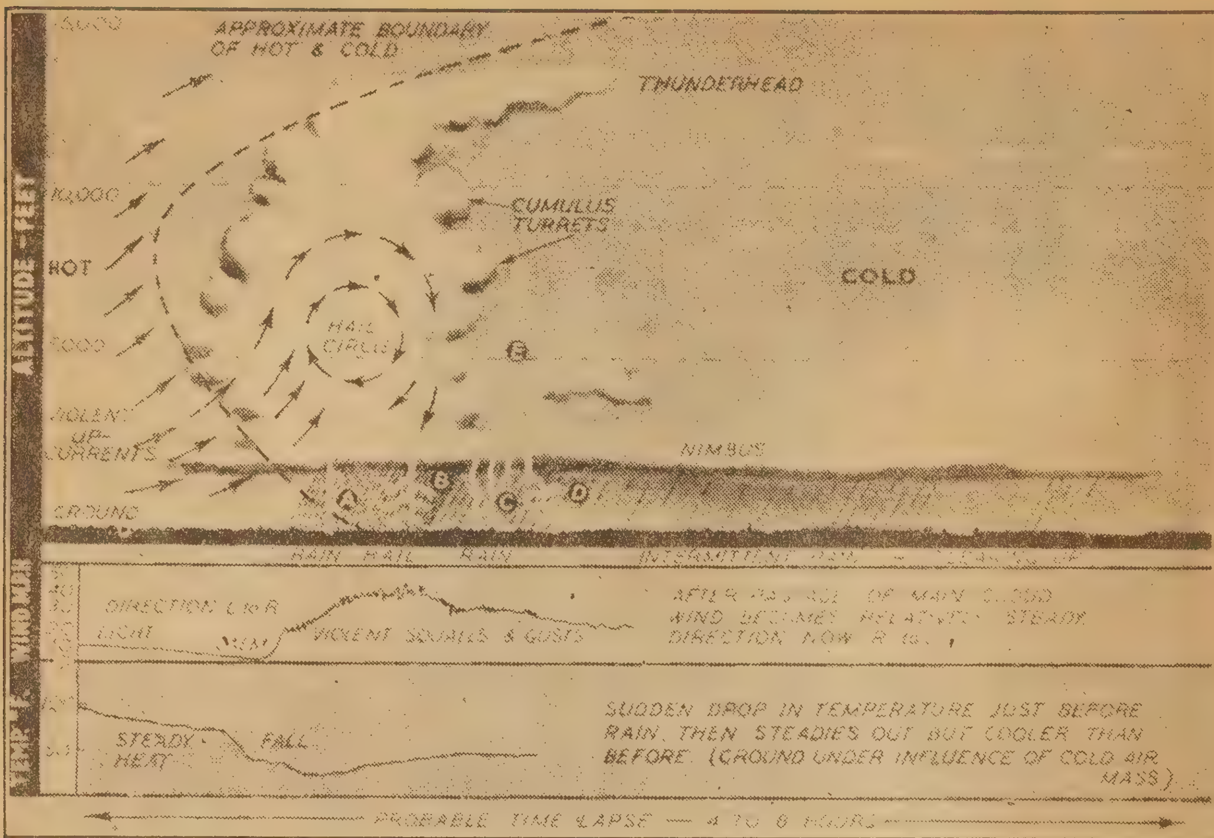
CONVERSION OF COAL TO OIL

One other aspect of hydrogenation which has recently become very prominent in connection with the preparation of motor spirit is the hydrogenation of coal to form liquid fuel. Bituminous coal consists mainly of carbon, hydrogen and oxygen in which there is usually a small impurity content of sulphur and other bodies. Oil is far more rich in hydrogen than coal to the extent, in fact, of 14 per cent., and the hydrogen in bituminous coal is in the neighborhood of 5 per cent. An additional 10 per cent. is required for the weight of solid fuel.

The conversion of coal to oil is, in itself, not complicated. The solid fuel is mixed into a paste with about 40 per cent of its own weight of heavy oil. The catalyst is added to this mixture and the whole is pumped into a heated vessel through which hydrogen is passing at a very high pressure. At the end of the operation during which the mixture is mechanically stirred, a thin, tar-like product can be separated, and from this liquid manner, fuel of a particularly satisfactory nature can be produced. As will be quite clear, the use of even 10 per cent. of hydrogen implies the manufacture of 40,000 cubic feet of gas to convert coal into one ton of petrol, but it has been estimated that in the case of English coal the cost of this process would be not much more than 7d per gallon of spirit.

In making one ton of petrol, about four tons of coal are necessary on account of the various subsidiary processes, so that if the national consumption of petrol is taken at 3,500,000 tons per year, the coal required would reach the enormous figure of 14,000,000 tons in one year.

One striking feature is that, as in the case of hydrogenated lubrication, the ultimate product is sometimes more suitable for general consumption than that directly obtained by natural processes. It is no exaggeration to state that the effect of hydrogenation developments upon industry could prove a vital factor in British economics.



General picture of a typical thunderstorm.

Of all the forces of nature the thunderstorm ranks first in spectacle and awesome grandeur. But lurking within its gigantic wall of cloud are vast potential destructive powers.

ABOUT THUNDER AND LIGHTNING

THIS power is one for which mankind has had the greatest respect during his whole history. He has often incorporated this fear of lightning into his religious beliefs and folklore.

Even recent times has not effaced some of the superstitions and fallacies connected with the behavior of lightning.

For instance, it is a common practice on the approach of a storm for women to put away the silver and cover the mirrors in the belief that these are attractive to lightning. There is no evidence to support these ideas. The practice may lead to misunderstanding by a visitor, who may call at the precise moment one is locking the silver in the cupboard.

The belief that getting into bed affords protection from lightning by the insulation afforded by the bedding is equally erroneous. If lightning is to strike, then being in bed affords nothing more than a saving of someone else's time in putting you there afterwards. Bed is a dangerous place at any time. More people die in bed than anywhere else.

Some people open their windows during a storm in order to allow the lightning to go right through the house and out the front door without doing any damage. Others close their windows to keep the lightning out altogether. To reconcile these two viewpoints is rather difficult, but one can be assured that if the house is in the direct path of a flash the lightning is not going to run around the house looking for an open window, like a burglar in the night. Nor is a thin sheet of glass likely to offer any obstacle.

The best thing to do during a thunderstorm is to remain calm and look out the window at the spectacle, trying meanwhile to understand the processes which are at work within the thundercloud. It is the purpose of this article to assist toward that end.

by Calvin Walters

Much research has been carried out in recent years in regard to the nature of the electrical forces within a thundercloud, but before we consider this angle it would be as well to follow the development of a typical thundercloud.

During a hot day it is sometimes noticed that white, fluffy clouds develop over high land or ranges. These are called cumulus clouds and each cloud represents the summit of a rising column of warm air.

The cloud is formed at the summit because at that height the moisture which has been carried with the air condenses into tiny droplets of water.

It often happens that these cumuli clouds grow into gigantic proportions, so that the top of the cloud may reach a height of up to 50,000 feet. These are the thunderclouds and are termed cumulo-nimbus.

Under ordinary conditions the temperature falls about one degree for every 300 feet one ascends into the air, but rising air cools at a much greater rate.

It is on hot, humid days that rising currents are mostly in evidence. Consequently, the large amount of moisture present encourages the formation of cloud. When the humidity is excessive the amount of moisture causes the cloud to grow to such an extent that a thunderstorm develops.

As the thundercloud develops, it will be noticed that a breeze springs up moving toward the storm, while the storm moves toward the breeze.

This is a necessary condition for the development of a storm, for the following reason.

Imagine a mass of hot air moving from the west against a mass of cooler air moving from the east. Under such conditions the cooler air forces its way under the hot air, pressing the latter upward, where it passes into regions of lower atmospheric pressure, and so expands.

In expanding, the warm air cools, and thus gets colder and colder as it rises.

At a certain stage, the warm air cools to the dew point, and drops of water are deposited. This usually takes place at the base of the cloud. If the air is to continue rising, it must always be warmer than the air which it displaces. In a thundercloud this condition is partly met by the fact that, in depositing water, the latent heat of condensation is given back to the cloud, which is thereby warmed again.

REPEATED PROCESS

Thus, the uprising air is kept warmer than the air it displaces, and continues to rise, expand and deposit water. This process is repeated until the updraught of air rises to a height of some 35,000 feet, at which point the air no longer falls in temperature.

At this height most of the water droplets, which have been supercooled, freeze to small ice crystals of soft hail and snow. As they fall they grow in size, and either fall from the cloud as hailstones or melt and fall as rain.

In falling, these hailstones create a downdraught of cold air, which, in turn, forces its way under the warm uprising air. This air rises and repeats the foregoing process.

It will thus be seen that continual repetition of the process gives rise to great turbulence inside the cloud. A great uprush of air continues to drive into the base of the cloud, and so the cloud continues to build up into an enormous structure from five to 10 miles across at the base and a height of 35,000 feet up to 50,000 feet in the tropics. The base of the cloud is from a half-mile to two miles above the earth.

SUPER-COOLED WATER

In some parts of the cloud the water exists in a super-cooled form, although it is at a temperature below the freezing point of water. It is these supercooled drops which are dangerous to aircraft, because they are responsible for the formation of ice on the wings. This is the "icing conditions" so often mentioned.

The updraughts of air in a well-developed thunderstorm are very violent. Draughts of 70 miles per hour have been measured. These are so violent that aircraft flying at 150 miles per hour have been forced upwards by as much as 6000 feet, or downwards by 2000 feet, while flying in one of these clouds.

The violence of the updraughts can often be gauged by the size of a hailstone. Hailstones are not solid lumps of ice, but consist of successive layers, like an onion.

This is brought about by the hailstone being carried upwards time and time again within the cloud, each successive rise being responsible for the deposition of a fresh layer of water, which in turn freezes.

Thus the hailstone is built up in size until it is too heavy to be supported by the updraught, and it falls to the ground.

The average diameter of large hailstones is about three inches. These fall to the ground at a speed of from 60 to 90 miles per hour and require an updraught of about 60 miles per hour to support them.

BIG HAILSTONES

In exceptional cases hailstones of five inches diameter and weighing about 1¼lb, have fallen. Happily, this has not occurred too often, as these fall to the ground at the rate of 260 miles per hour. They require an updraught of 260 miles per hour to support them within the cloud.

We must now pass on to the electrical phenomena associated with the thunderstorm.

The cloud can be likened to an electric generator, which builds up enormous potentials, which sometime must be released. That these generators are nothing more than water and ice thrown about by the turbulence of the wind is a remarkable fact.

Investigation has shown that the high top of a thundercloud carries a positive charge and the base carries a negative charge.

How the water droplets in the cloud acquire their respective charges is a matter which, up to the present, has not been decided.

The theory of Frankel suggests that the water at the base of the cloud becomes negative because it has an attraction for the negative ions in the surrounding air. By robbing the surrounding air of negative ions, it leaves an excess of positive ions in it.

The theory of Simpson says that the particles of ice become negatively charged by friction. Thus the ice particles, which are always high in the cloud, rob the surrounding air of negative ions, leaving an excess of positive ions behind. As the large ice particles fall and melt into raindrops, they thus give rise to the negative charge at the base, leaving the positive charge at the summit of the cloud.

Another theory which has been shown to operate in laboratory tests is a little more complicated. It has been worked out by C. T. R. Wilson.

He suggests that because of either of the two theories described above there is a positive charge at the summit of the cloud and a negative charge at the base. Thus, any drop of water or ice in between the two will have an induced negative charge on its upper half and an induced positive charge in its lower half.

Air carrying positive and negative irons will be streaming upwards past these drops and a negative ion in the air will be attracted to the positive end of the drop. On the other hand, a positive ion will be repelled by the positive end of the drop and will be carried past the drop to the top of the cloud.

Thus the air is robbed of negative irons and the now excessively positive air passes on to the top.

It is thought that all three processes are at work in the cloud, so that eventually we have a state where a negative and positive pole exists at opposite ends of the cloud separated by a neutral region of a mile or more in height. This separation of the charges is brought about by the wind within the cloud.

The mechanical work done by the wind is responsible for the vast electrical energy in the cloud and the existence of potentials amounting to anything from 100-million to 1000-million volts.

It appears that each thundercloud is a separate entity, and where two or more exist side by side the lightning does not flash from cloud to cloud as it often thought.

In a cloud flash the two poles of the cloud are brought together and

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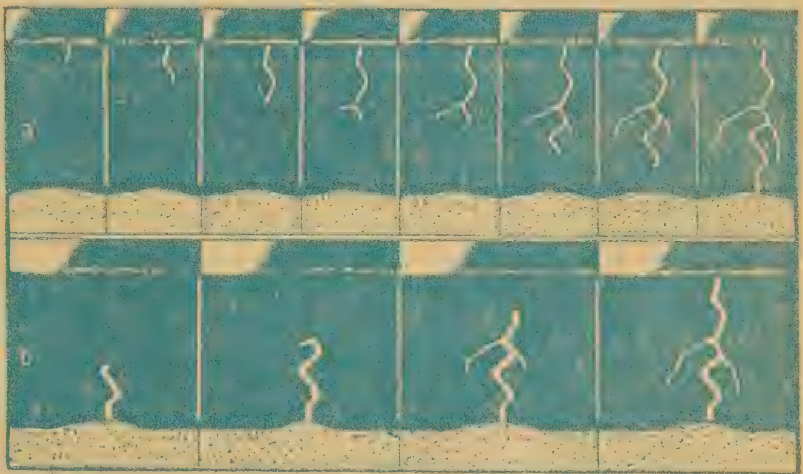


How a lightening stroke develops. Strip "a" shows the leader passing from the cloud to the ground, and "b" the return stroke from ground to cloud. Intervals of "a" are three thousandths, and at "b" thirty millionths of a second.

Technical Review

TRANSISTOR MAY REVOLUTIONISE ELECTRONICS

Because of the great potential value of the transistor to modern radio, we devote most of our Review pages this month to an excellent article which appeared recently in "Electronics." Dr. V. Zworykin during his recent visit to Australia said that the development of the transistor was of the highest importance to electronics.

TWO years ago Shockley of the Bell Laboratories described the theory of a junction transistor made of a single crystal of germanium, the germanium being so processed that the crystal is composed of three parts, as shown in the drawing of Fig. 1. The outer ends of the crystal are made of the so-called negative or *n*-type germanium, which contains a particular type of impurity (for example arsenic). These are joined by a thin section of positive or *p*-type germanium, containing a different impurity (for example gallium). The *p*-type has an excess of positive carriers ("electron holes") while the *n*-type has an excess of negative carriers (electrons).

CONNECTIONS

Electrical connections are made to the three sections of the transistor as shown. The centre section, called the base, corresponds to the grid of a vacuum tube; the end sections are the emitter and collector, corresponding respectively to the cathode and anode of a vacuum tube.

When a signal current flows through the base and the emitter, a larger variation in current between collector and emitter results.

The static characteristics of Fig. 2, which resemble the plate family of a beam-tetrode vacuum tube, indicate the degree of amplification thereby produced. If the collector current I_c is held constant, very small changes in emitter voltage will cause enormous changes in collector voltage V_c.

The amplification between them may be as much as 10,000 times (80 db) in voltage when the terminal impedances are such as to develop the maximum d-c gain.

POWER GAIN

In a-c amplifiers, the junction transistor can provide 40 to 50 db of power gain per stage. While gains of this order are theoretically possible in vacuum-tube amplifiers, they are seldom achieved in practice. Moreover, the high gain of the junction transistor amplifier is accompanied by unheard-of efficiency in the use of the applied voltages and currents, partly because no filament-heating power is required and also because about 95 pc of the theoretical maximum plate-circuit efficiency is achieved.

ADVANTAGES

When the transistor was first announced in 1948, the device consisted of a block of uniform germanium on which two pointed cat-whiskers made contact. This point-contact type immediately attracted wide attention as a device which had potentially long life and would amplify without filament-heating power, but it failed to immediately displace vacuum tubes (except in a few special applications) because of certain early problems that arose.

First and foremost among these was the high noise level, as high as 50 to 60 db above the theoretical limit. Second was the limit on the frequency of operation, to not more than a few megacycles. Third, and most important, this transistor was not reproducible nor reliable, at least in the early designs.

NO COMPETITOR

Finally, its gain was not appreciably greater than that available from vacuum tubes, and its power-handling capacity was notably less than that of receiving-type power tubes. Consequently, the point-contact transistor is not a competitor to vacuum tubes in the low-level input stages of radio receivers, where low noise is essential, nor in the output stages where high power or voltage is essential.

On the other hand, current results with point-contact transistors show that they can now be made on developmental level with reproducibility of current vacuum tubes and reliability in excess of that obtainable with tubes. Such transistors are finding widespread usage in switching and computing circuits where negative resistance and high-frequency response are important.

The n-p-n junction transistor, it now appears, has removed all of these limitations except one (limited high-frequency response) and there is every right to hope that this remaining limitation can be overcome in time.

MANY USES

As a result, when the problems of mass production are solved, it appears that the junction transistor may compete directly with receiver-type vacuum tubes in virtually all applications involving signal frequencies lower than a few megacycles and gain-bandwidth products of the order of 100 mc.

The extremely high efficiency and absence of heating power fit it particularly for applications involving mass assemblies of amplifiers and trigger circuits, such as electronic computers. Its ruggedness, reliability and long life fit it for parts of the telephone system, notably local switching and subscriber circuits, where vacuum tubes have hitherto never been used.

A recently developed theory of noise in transistors, details of which have not yet been published, indicates that the noise inherent in a

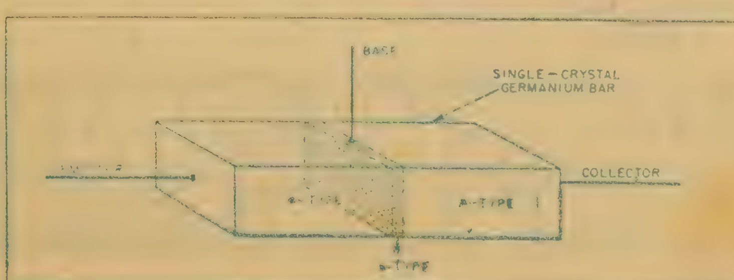
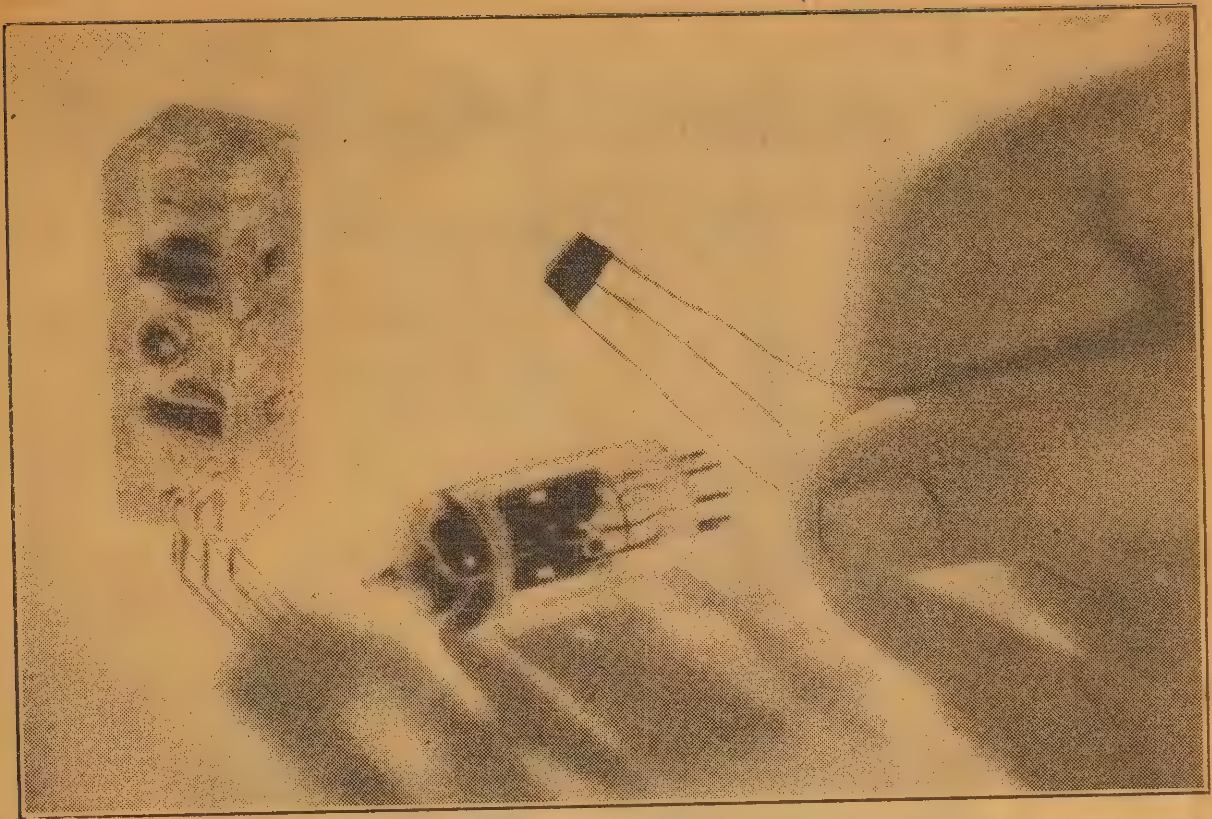


Fig. 1—Diagram of the junction transistor. A thin section of p-type germanium is formed as part of a single crystal in intimate contact with two larger blocks of n-type material.



Developmental model of junction transistor illustrated (black object with three leads being held) as compared to a 6C4 miniature triode and an experimental model of a two-stage transistor amplifier embedded in clear plastic. The amplifier has a power gain of 90 db in the audio range.

plane junction between n and p germanium should be substantially lower than that associated with a point contact. Measurements on the n-p-n junction transistor confirm this; in fact the units thus far produced have noise figures between 10 and 20 db above the thermal limit. This represents an enormous improvement, about 30 to 40 db, relative to the noise levels of the point-contact type.

While still not the equal of the best vacuum tubes, operating at the same frequency range, the theory indicates that a reduction of noise figure to below 10 db can be achieved in the junction transistor as better techniques of design and manufacture are developed.

Circuit stability is another noteworthy characteristic of the new transistor. In the early point-contact form, negative impedances would develop in certain circuit connections. This is not always a disadvantage, especially in pulse-handling circuits for switching and computing applications.

STABILITY

The junction transistor has positive impedances between all terminals, whether connected in the grounded-base, grounded-collector or grounded-emitter circuit. Resulting flexibility or circuit design permits conventional input and output circuits.

Excellent stability is achieved in another sense, the ability to withstand severe mechanical shock.

The junction transistor is inherently rugged. It consists of a single crystal of germanium, about 1/8 inch long, to which are fastened, mechanically and electrically, three leads. The assembly is then covered with a plastic shell.

Although no figures in shock resistance have been published, it would appear likely that this assembly can stand at least as great a shock as any vacuum tube, including tubes designed for proximity fuzes. No measurable micro-phonism has been detected in any of the junction transistor yet built.

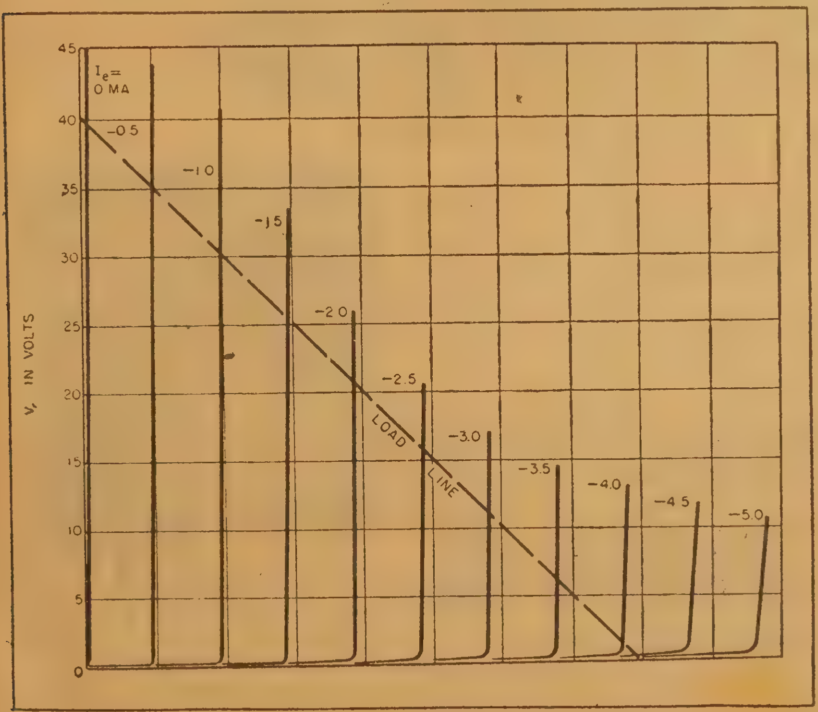


Fig. 2—Static collector voltage and current characteristics of the junction transistor. Note general similarity to the plate family of a beam tetrode.

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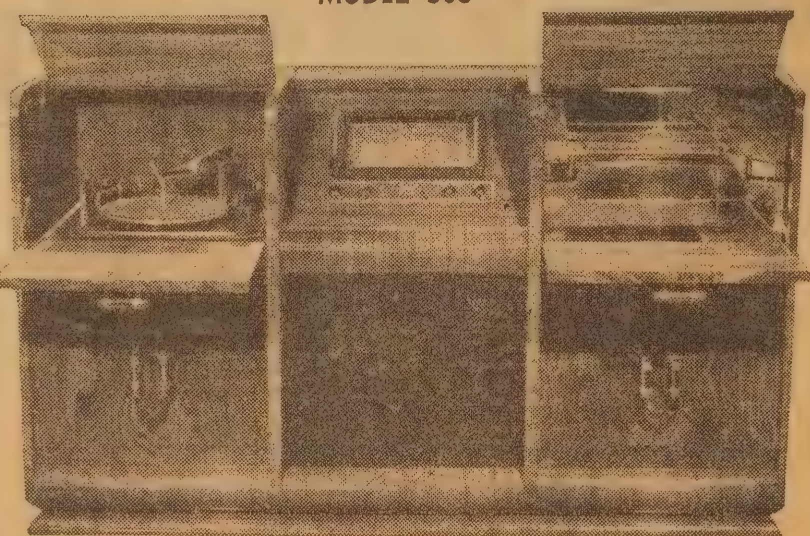

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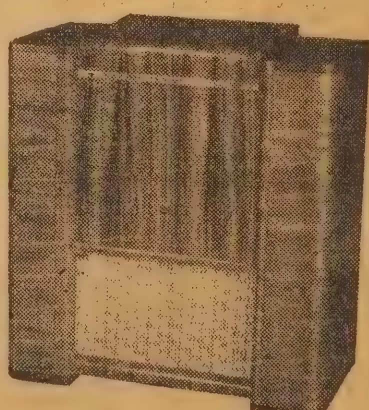

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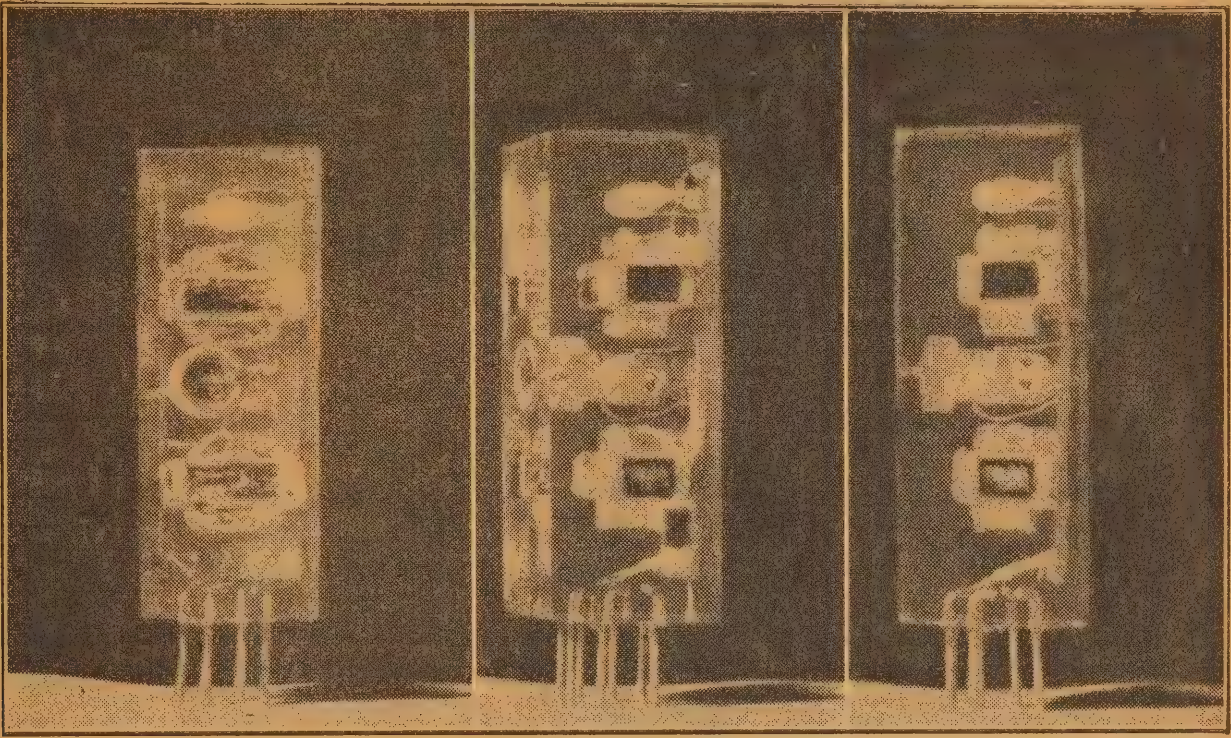

Three views of the Transistor amplifier. Experimental model transistors are visible in the amplifier as white, plastic-covered beads. Transformer and other components are also visible. Unite will operate continuously for months with one penlight cell as sole power.

The power-handling ability of the point-contact transistor is severely limited by heating at the contact itself, which must be of small area and high thermal resistance. In the n-p-n junction transistor, the currents pass over two interfaces between the n and p types of germanium, which may be of substantial area. As a result, power levels of at least 2 watts may be handled in units specially built for power service.

Most of the transistors thus far built are of smaller size and operate at tens of hundreds of milliwatts maximum output power. But there appears to be no fundamental bar to handling power levels equal to that of any receiver power tube.

EFFICIENCY

As a result, a broadcast band receiver with normal sensitivity and power output can now be built completely without vacuum tubes.

Efficiency in the use of the power supply is far better than that of any vacuum tube ever built. The complete absence of filament-heating power is evident. This accounts for a saving of from several watts (in power output tubes) to about 50 milliwatts (in hearing-aid tubes).

Over and above this, practically no power is lost in the collector circuit, corresponding to the plate circuit of a vacuum tube. In class A operation, the theoretical maximum plate efficiency is 50 pc. Junction transistors operating class A have efficiencies as high as 49 pc, and similar high performance is achieved in class B and C operation.

By far the outstanding property of the n-p-n junction transistor is the unbelievably small level of power consumption required to achieve useful operation. Since the static and dynamic characteristics are the closest approach to the ideal yet achieved in any electronic amplifying device, the transistor amplifier requires only microwatts of power input to amplify signals to the level of microwatts.

Outstanding Properties of Junction Transistors

- Noise figure is in range of 10 to 20db at 1000cps.
- Positive input and output impedance for all connections.
- Power gain of 40 to 50db per stage has been obtained.
- Class A efficiency, as high as 49 pc of possible 50 pc.
- Extremely small in size, as shown in illustration.
- Relatively free from microphonic noise distortion.
- Frequency response can be flat to at least one megacycle.
- Power consumption is from one microwatt to several watts.

One junction transistor, operating in an audio oscillator circuit, will oscillate stably with a power supply of 6 microamperes at 0.1 volt, or 0.6 microwatt. This is less than one-millionth of the power required for the filament heater alone in a conventional receiver tube (6.3 volts at 0.15 amp), and is, in fact, less power that that developed by a flea jumping once every eight seconds. Ridenour calls this not flea power, but "lazy flea power!"

In applications where less than a milliwatt of plate power suffices, the power consumption is so small that junction-transistor amplifiers can operate continuously for months or years on ordinary small dry batteries. Moreover, operation is quite feasible with a total applied voltage of from 1 to 2 volts, so single-cell batteries suffice.

The important remaining limitation in the operation of the new transistor is frequency of operation and bandwidth. Since the junctions between n and p portions of the germanium crystal are of substantial area, the electrical capacitance across them is correspondingly large.

GAIN

Full gain is limited by collector capacitance in the present units to a few kilocycles, but by the use of appropriate impedance mis-matching, the frequency response may be extended uniformly to at least one megacycle. At the moment, the useful upper limit, as determined by transit time dispersion, seems to be in the vicinity of 5 mc.

The frequency limit is imposed, in part, by the fact that the electrons and holes involved in the amplifying action must pass from the emitter to the collector by diffusion through the base layer. Thus the thicker the layer, the lower the frequency limit, the frequency varying inversely as the square of the layer thickness.

By producing thin base layers, the frequency may be extended upward rapidly. Thus, by a reduction in layer thickness by somewhat more than three times relative to that of present units, the frequency limit

(Continued on Page 23)

MORE ABOUT LAWRENCE COLOR TUBE

In our November issue we gave some details about a new color tube for television developed by Prof. E. O. Lawrence. Some further facts on this tube were recently published in Electronics by an eye-witness of an actual demonstration. Here are his reactions.

A NEW version of the tricolor picture tube developed by Prof. E. O. Lawrence of the University of California was demonstrated to the Press, at the laboratories of Paramount Television Productions in New York.

The cellular structure of the older Lawrence tube has been abandoned in favor of a linear arrangement of phosphor strips and wires. The viewing screen consists of 1200 vertical strips of phosphor which fluoresce individually in the three primary colors.

Reading across the screen, the color of the strips is RGBBGRRGB and so on, where the letters stand for red, green and blue. In the experimental model the active width of the viewing screen is about 11 inches. In the demonstration, scanning was at 525 lines, 180 fields by the field-sequential method.

SINGLE GUN

A single electron gun is used, operated at a second-anode potential of 3000 volts. The beam is deflected horizontally, across the strips, in the usual manner over a maximum scanning angle of about 70 degrees.

The beam passes through a grid of 400 vertical wires, placed parallel to, and 0.4 inch from, the phosphor screen. A post-deflection voltage of 9000 volts is applied between the wire grid and the phosphor, so the electrons hit the phosphor strips after having been accelerated through a total voltage drop of 12,000 volts, but the line-scanning circuits need only deflect the beam at the 3000-volt level. Consequently the scanning power requirement is moderate.

The wires in the grid are accurately aligned with the phosphor strips, so that three strips lie in front of the space between two adjacent wires. The spacing between the wires is 0.04 inch, and the space occupied by three strips is 0.0408 inch. Consequently the strips at the outer edges of the viewing screen are displaced outward from the assoociated wires, to accommodate the scanning angle.

REGISTER

Precise register between strips and wires in these outer regions is accomplished by manual adjustment of the post-deflection voltage.

The geometry of wires and wire-phosphor spacing is such that the post-deflection voltage causes a focusing action as the electrons pass from the wires to the phosphor screen, somewhat after the manner of electron focusing in a beam-tetrode tube.

As a result, the beam is focused to a width of a few mils, less than the width of the individual phosphor strips. Consequently the lateral displacement of wires with respect to the strips need not be controlled more precisely than about half the width of a strip or about 5 mils.

Selection between color strips is accomplished by deflecting the beam as it passes between wires. If no color-deflection voltage is applied, the beam passes undeflected to the green strip at the centre of each group. When the color-deflection voltage is applied in one polarity the beam moves to the left or right, depending on the polarity of the adjacent wires, hitting the red strips, while the reverse polarity of color deflection causes the blue strips to be excited.

The color deflection is arranged by connecting alternate wires on the grid to common terminals, the two sets of alternate wires serving as the two elements of the deflection system. A color deflection voltage of 400 volts, peak, is required to swing the beam from the green strip to the red strip or to the blue strip. The capacitance between the sets of grid wires is 1000 uuf.

DEFLECTION VOLTAGE

As applied to the CBS field-sequential system, the color deflection voltage is applied at the end of each field, fundamental period of the deflecting wave being 3/144 equals 1/48th second. Allowing ten harmonics to secure a rapid shift from one color to the other, the maximum color deflection frequency is thus under 500 cps. As the fundamental frequency of 48 cps, the color-deflection voltage across 1000 pj. produces a reactive current of less than a milliampere, at a wattless power of less than one voltampere. When the tube is applied to a compatible color system in accordance with the tentative NTSC standards, the color switching rate is that of the color carrier or 3.89 mc. At this frequency the corresponding wattless power for deflection is several thousand voltamperes. It thus appears that the new tube would be difficult to use in a compatible system of this type, in which the color swtiching rate is well above 3 mc.

Those observing the demonstration noted that the vertical line structure was prominent, even at viewing distances well beyond five times the picture height. This may be due in part to the fact that two red strips and two blue strips are adjacent, as is required by the color deflection method, and in part to the fact that all the picture elements in one color are accurately aligned so the eye can discern the lines more readily than if the elements were mor heterogeneously arranged, as in the RCA tricolor tube. The color values were not equal to those demonstrated by CBS and RCA, since the experimental nature of the tube had prevented baking out the binder in the phosphors. The Paramount officials announced plans to continue the development in a recently acquired plant in Stamford, Conn. Details of this and modified versions of the tube have been promised and will be published in an early issue.

TRANSISTOR MAY REVOLUTIONISE ELECTRONICS

(Continued from Page 21)

could be increased 10 times. The bandwidth limit imposed by the collector capacitance can also be extended by several conceivable modifications of design.

As in other amplifiers, the frequency limitation is most generally expressed as the gain-bandwidth product. Computations for a grounded-base stage indicate that the measured values of capacitance and resistance will produce a gain-bandwidth product of about 120 mc.

The corresponding value for the same transistor in a grounded-emitter stage is 1300 mc, and in a grounded-collector stage 15 mc. These figures indicate that appreciable gain can be had at values well above 1 mc.

From the standpoint of the design and application engineer, it should be emphasised that the junction transistor is in an early stage of development and that many problems remain to be solved in the production of the units, particularly in achieving uniform characteristics. But the basic principle of operation is now well established, in theory as well as practice, and it can be confidently expected that the new transistor will extend materially the range of application of electronic devices.—D.G.F. and R.K.J.

DR. ZWORYKIN TALKS ON TELEVISION

(Continued from Page 13)

in each unit. But he is impressed with the possibility of simplification offered by devices such as the transitron, which, despite its "half-a-pea" size, is capable of replacing so many conventional valves. He thinks they are likely to revolutionise electronic equipment, and that soon.

He is also impressed with the possibility of using methods other than films for recording television programmes. Whether there are undisclosed developments in this field is open to guess-work, for he would not enlarge upon it. But if any encouragement is needed to believe that television techniques are rapidly advancing, I feel sure Zworykin can supply it.

It is a long time since we were visited with a man of Dr. Zworykin's calibre in the electronic field. His work and reputation are such that we can hail him as a man destined for a place among the history makers. In the television saga, we will remember him with Baird and McGee of England as an outstanding and honored visitor to our shores.

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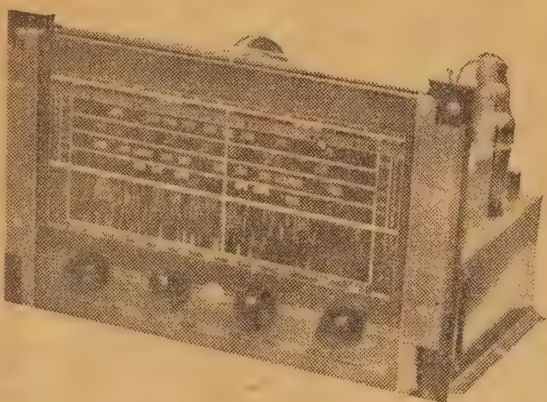

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NEWS AND VIEWS OF THE MONTH

Saving planes from fire

ONE of the greatest hazards faced by airmen in time of war is from fires started by the bullets of the enemy.

Many aircraft have been shot down not because they have been put out of action mechanically, or because the pilots have been killed, but because bullets have set fire to the petrol tanks.

It is reported that RAF explosive experts have developed a device, which will prevent petrol tanks from catching fire when hit.

Methods used to date include pumping nitrogen into the tanks to prevent fire from developing. Nitrogen, being a non-supporter of combustion, choked back the flames before they could cause damage.

PLACED IN TANKS

The new device consists of a container about as big as a small orange containing carbon tetra-chloride, which is placed in the petrol tanks. The device is operated by a diaphragm which ruptures when subjected to the pressure of an explosion.

Petrol explosions, as most engineers know, don't occur instantaneously, but develop over a period of time occupying an appreciable part of one second.

The new devices will operate when the pressure changes suddenly by as little as 3lb per square inch.

Thus, when the explosion occurs, the carbon tetrachloride is released before it has time to develop.

Tests at the RAE, Farnborough, where the RAF conducts its research, showed that whereas an untreated petrol tank burst into flames when hit with a tracer bullet, one containing the new device did not.

Other uses are visualised for these things, and they are expected to be effective in many cases where there is a risk of an explosion from chemicals, coal or gas.

* * *

The old wail

ONCE again we'd like to make a plea for more care and consideration by the broadcasting companies in their presentation of music.

Recently we heard two classic examples of how to do it and how not to do it.

Station 2SM showed us how. They presented a recording of La Boheme on a new Decca long-playing disc. The performance is a really fine one, which is more than can be said about the normal opera recording—even some which have been released on long players.

The session was sponsored by Palings and Mr. Leon Packer gave an excellent commentary. His advertising plugs were so unobtrusively worked in that one could hardly wait until next day to raise a hat to Palings for their restraint.

Once again there was an interval between the last two acts, and time allowed to come to the surface after this somewhat emotionally strenuous opera.

The point is that all concerned went to plenty of trouble to do justice to themselves, to the music, to the listener, and to the standard of broadcasting generally.

Now compare 2UW a week or so later. It was symphony hour time —a Sunday evening when lots of people were ready to enjoy a little symphony music. In fairness to 2UW, we readily agree that this is a good session, as evidenced by the fact that we waited for it.

POOR START

The symphony was Beethoven No. 3—the Eroica. That's a pretty fine work. Again, a Decca long-playing recording was used, and it's a pretty fine recording.

The announcer began by reading his introduction quite well (in marked contrast to the patronising blurb we hear sometimes), but he fluffed the start of the record in his eagerness to get the first notes on the air two microseconds after he had finished speaking.

POPULAR SCIENCE QUIZ

Q.—Why do stars appear to twinkle?

A.: Because of the great distance which separates us from the stars, the light we receive from them is only a small proportion of the total light radiated. Those light rays which we do receive travel along various paths due to refraction by the earth's atmosphere and hence all do not arrive at the same instant. Thus, to the naked eye of an observer on the earth, the light from a star is not uniform in intensity. The overall result is that a star appears to twinkle, meaning really that the amount of light received is varying.

Planets subtend a much larger angle to the eye of an observer than do stars and consequently more light is received at any instant. Refraction effects are less noticeable, so planets do not appear to twinkle.

This reasoning is supported by the fact that when large telescopes are used to view stars, no such twinkling is noticed. This is due to the amount of light collected by a telescope remaining fairly constant.

Q.—Why is it that the outline of the sun or moon appears to change from the circular when near the horizon?

A.: As illustrated in the previous answer, refraction of light rays by the earth's atmosphere can play some odd tricks. The apparent flattening of the outline of the sun or moon is also due to refraction of light rays upon nearing the earth. The apparently larger physical size of the sun and moon compared with the more distant stars and planets gives rise to this illusion.

It is brought about in this way. Rays from the lower part of the sun or moon are refracted more than those from the upper because they travel for a greater distance through the earth's atmosphere. This results in the lower portion of either of these two bodies appearing to be at a greater height than it really is. The upper portion is not affected as much. The sides are at equal altitudes and light rays from these portions are acted upon to the same extent by the earth's atmosphere.

The overall effect is to make the sun or moon appear elliptical instead of circular. Of course, the effect will vary with major changes in meteorological conditions.

Q.—What are mirages and what causes them?

A.: A dictionary interpretation of a "mirage" refers to it as being an optical illusion causing objects below the horizon to seem to be above it. There are, in the main, two types of mirages, those which occur in hot regions and those which occur in cold regions. In hot regions, pools of water appear to be on the surface of tarred roads or similar surfaces. This occurs when the sun is at a certain height and shining obliquely upon water at some point below the horizon and along, say, a tarred road with the observer in a certain position facing the direction of the sun.

Light rays, reflected from the water surface, travel through air layers of varying optical density and gradually change their direction until they strike some layers at angles greater than the critical angle. These rays are thus refracted towards the earth. Some of them travel nearly parallel to the earth's surface and give the illusion of pools of water being on the surface of the ground at a short distance from the observer.

Over the sea during hot weather and in arctic regions, mirages can be seen in the sky as inverted images of some large object such as a mountain or stretch of land. The cooler and more optically dense air close to the surface of the earth causes refraction of the rays of light from the object and makes them appear to originate from an elevated position against the sky.

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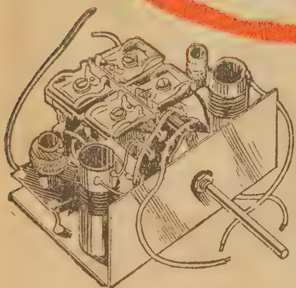
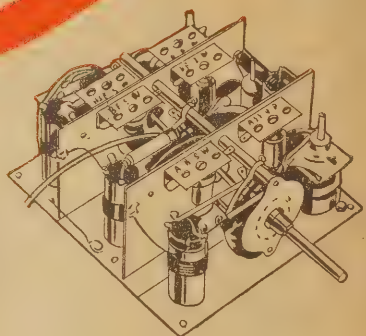


K1 KIT

K1. A dual wave assembly incorporating permeability tuning aerial and osc. coils for B/C (550 1600 Kc) and S/W (7-23 Mc.) Trimmers and padder (fixed) condensers fitted. Iron core adjustment is made from above chassis (trimmers from beneath). Measurements: 2¼" long, 3¾" wide, 1 7-8" high.

K2 KIT

K2 A dual wave assembly with same coverage as K1 type and incorporating R.F. stage. All coils permeability tuned and matched for "AWA" and "H" gangs. Constructed on sub-chassis measuring 5⅜" long, 2 7-8" high, 5½" wide.



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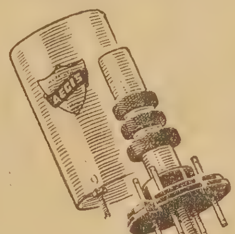

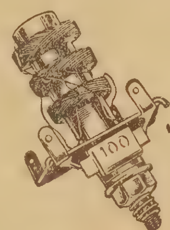

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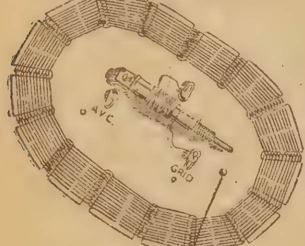

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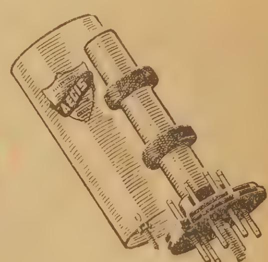

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Unfortunately, the opening chords of this symphony are vital to the sense of the movement. Plenty of dentures must have suffered severely as the music came in six bars too late.

About halfway through the first side we heard snatches of a ghost voice, apparently from some irresponsible microphone, and a few other noises which defy description.

Changing to the second side, normally a fairly easy matter, we were treated to a horrible swipe of the stylus, an effect that brought us out of a comfortable chair, teeth on edge. Nothing more, we thought, can now happen!

We were mistaken. Precisely 30 seconds before the conclusion, the announcer faded in with the news that he couldn't finish the symphony in the time, and was, therefore, handing over to the midnight to dawn specialist. Then, believe it or not, he proceeded to finish after all, by fading back the last few triumphant bars just to show that he didn't really wish poor old Ludwig any permanent violence.

TAKE TROUBLE

Our mood of gentle humor in relating this factual story has come with time, but our immediate feelings were so unfriendly towards the station, the announcer, and other people who probably weren't to blame that we almost lost a night's sleep.

Friends of the ether, it is worth while taking more trouble than this over a decent session and decent music. If you promise listeners a special treat by playing such fine records, don't antagonise them by handling the mechanics in this infantile fashion.

In fairness to all, such things don't always happen. It's an even chance now that the time signal will not be allowed to come through the middle of some good programme, for which blessing alone we should cherish optimism.

But ordinary common care in presentation isn't a thing for which we should be grateful. It's something we should expect. Nobody will grudge a few minutes lopped off the midnight to dawn sessions — they've got all night. If they can't be lopped, then surely it's worth while timing the programme in advance to allow something in hand.

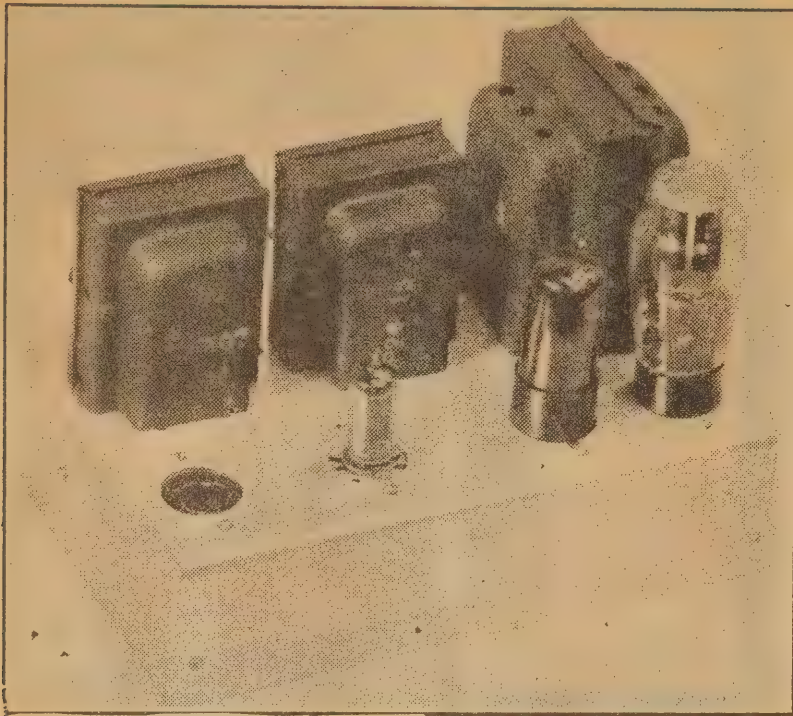
We'll still listen to the symphony hour. But, we hope, never again with such a disastrous result.

METALS IN MAN

HUMAN hair, skin and nails contain 19 different metals. Minute quantities of heavy metals such as silver, lead, tin, zinc, iron, copper and aluminium are among those included. Other metals which can be detected are barium, boron, sodium, titanium, strontium, potassium, calcium, phosphorus, magnesium and manganese.

FOR THE MOTORIST

TO get a close approximation of the distance of motor trips, first mark a length of wire solder or some other soft wire at intervals corresponding to the mileage scale on your road map. Then lay the wire on the map, bending it to follow the route in question and note the distance in miles by the marks. Air routes can be estimated by marking the mileage on a straight-edge instead of a wire.



The chassis is the same as that used for the Playmaster Baby. The 6AU6 valve socket has a plate which mounts it in a standard size socket hole.

THE PLAYMASTER JUNIOR

The Playmaster Junior, No. 3 in the series, has all the characteristics of the larger types, but with an output of 4 watts. This is equal to the average radiogram, and adequate for ordinary home requirements. The Junior can, of course, be used with the control units and tuners which make up the remainder of this series.

by John Moyle

IN last month's issue, when describing the PLAYMASTER BABY, we pointed out that, with modern speakers, only large rooms and small halls really need more than about the four watts delivered by the standard type of output valve used today.

Although I am a believer in plenty of reserve power as an excellent insurance against distortion and overload, not everybody feels inclined to spend extra money to provide reserves which may rarely if ever be called upon.

AVERAGE VOLUME

It is rather an eye-opener to play an amplifier at an average volume and to measure the amount of power actually delivered under those conditions. For an ordinary room it is likely that the average power used will be less than one watt—in most cases a great deal less. Even on loud passages two watts would represent a really high level.

On the other hand, a large room would probably call for outputs several times greater, because the ear doesn't hear twice as much power as twice the loudness. That is why, when considering an increase in power, it isn't much good just adding on an extra watt or two. We will need twice as much power to make an even appreciable difference.

Conversely, of course, if our room is modest in size we can saturate it with sound quite easily with our four watts maximum power.

On this ground alone, therefore, we are justified in building a lower powered amplifier, knowing that it will fill the bill for a great many readers.

There are other points in favor of a small job which may be even more powerful arguments. Amplifiers call for power supply equipment and output transformers, both of which cost a fair sum of money. The cost of iron and copper has expanded this sum quite alarmingly during the last 12 months. And so if we can accept a lower output without losing essential quality our pockets will be a good deal heavier when we have finished paying for it. We also save a pound or two in valves as there are two less in the Junior as compared with the others. Add to this fewer odd parts and we find the total cost a long way down.

Considering now general performance we find that by taking reasonable care, and using a good output transformer, it isn't very hard to get a frequency response on a par with the PLAYMASTER and the PLAYMASTER SENIOR.

GOOD RESPONSE

In fact, the measured response of this amplifier is so good that we haven't even bothered to publish a curve. Between 100 cycles and 25Kc the output remains absolutely constant. It rises very slightly up to 30 cycles—actually less than 1 db. At 20 cycles the output falls by about 1.3 db, and below that we didn't bother to measure.

At the top end the response drops from 25Kc to about 1.4 db at 35Kc, rises slightly at 50Kc, and begins to fall away seriously above this point. At 70Kc it is down by about 4 db! That is a remarkably fine performance for any amplifier, and not likely to be exceeded in any significant particular.

Thus, over the range I have named as being important — 50-15Kc — we can consider the response as being perfectly flat.

This performance is due largely to the use of a large amount of inverse feedback. As in the earlier circuits, this is taken from the voice coil back to the cathode circuit of the first valve, thus including the complete amplifier in the network. With the circuit as shown, the feedback is equal to about 16 db, equal to a reduction in gain and distortion more than six times.

DISTORTION

There is, of course, fundamentally more distortion in a single ended amplifier than there is in a push-pull version. This is because we are without the cancellation of even harmonics which take place in a push-pull amplifier.

However, we can do a little estimating when remembering that for full output, the 6V6 is rated at 8 pc distortion. Our feedback of 6 times has reduced this by six times, and there is very little generated by the first valve, which in any case comes inside the feedback loop.

So once again we can hope for a

harmonic distortion figure of about 1 or 2 pc near full output.

Very rarely will the amplifier be used on an average at more than say, one-fifth of this figure. This means that a further distortion reduction takes place of at least this 5-1 ratio.

The result, as I pointed out at the commencement of this series, is that, played against the big amplifiers at ordinary room volume, one cannot tell the difference. The amplifier really sounds remarkably good.

Another point worth mentioning about the single ended stage is that it is harder to make high performance output transformers than it is with a push-pull amplifier. With the latter, the plate current of the two valves is arranged to flow through the windings in such a manner that one opposes the other. This means that the demands on the iron core are much less severe, improving transformer characteristics on almost every score.

EFFECT OF FEEDBACK

A single ended transformer, however, does not have this advantage, and one generally finds that the power-handling capacity falls off at the lower end of the scale unless it is a very large type.

As our reference to frequency response bears out, this tendency to drop can be greatly reduced by employing inverse feedback. Feedback, however, cannot do anything to improve the power handling capacity of the core, so that we find an output of 4 watts without distortion at 1 Kc dropping to about 3 watts at 50 cycles.

This isn't as bad in practice as it might seem, because only at very high levels would the amplifier be asked to deliver 3 watts at this frequency, and in fact, it will not often be fed with 50 cycles, anyhow.

The point is, however, that a good output transformer is most important with a single ended stage.

Luckily transformers are available with nominal ranges of from 50-10,000 cycles and even better. Feedback improves the response to a remarkable degree, as instanced by the results from this amplifier. This is fortunate for us, although there are many reasons why feedback should be used to make a good amplifier better, and not primarily to make a poor one good.

SOME DANGERS

The amount of feedback we should use in an amplifier of this kind is determined by a number of practical factors. Ideally, the more feedback we use, the flatter will be our response, and the lower the distortion. If we use too much, however, we may run into trouble.

Firstly feedback should not be so great that the reduction in amplifier gain is too great. We are fairly well placed on this score, and even with 20 db of feedback, the sensitivity is still below the half-volt mark.

Probably the first indication of excessive feedback is a tendency for the amplifier to motor-boat when played at high volume with a large amount of bass boost. This would be the case with the Control Unit No. 2, with the pickup in the LP position and the extra bass boost fully in circuit.

This amount of boost is too much for practical purposes. It is also too much on radio if played at a high level. Therefore, it isn't a cause for worry if you should be able to make the amplifier motorboat under these conditions.

With somewhat less feedback — about 15 db — there should be no tendency for the amplifier to motorboat under any conditions. In fact, it is more likely that you will experience acoustic feedback between speaker and pick-up before feedback dangers occur.

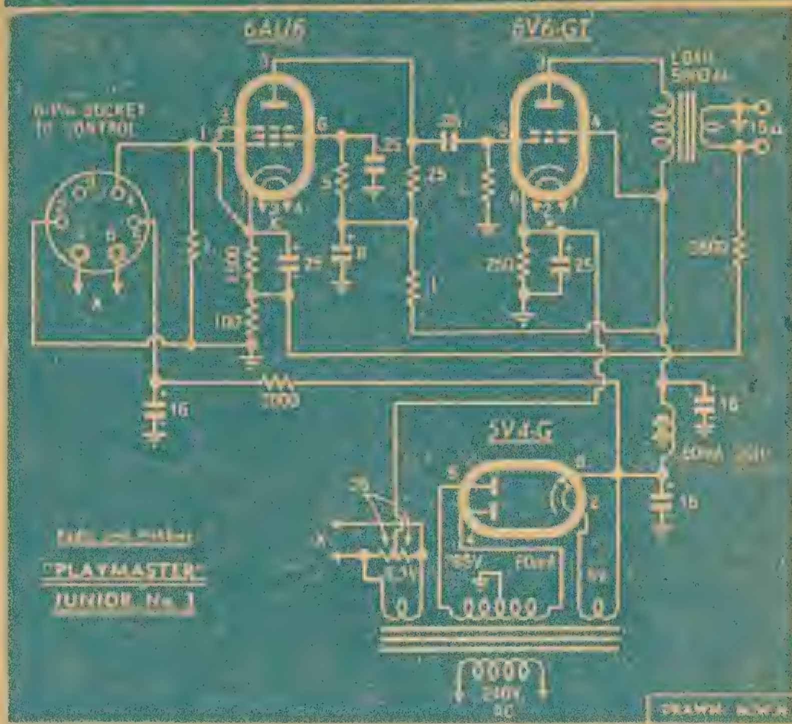
There is a somewhat complex set of reasons for motor-boating being more likely with high feedback. It is primarily due to the fact that, at very low frequencies, the gain of the amplifier falls away to well below the average figure. But the feedback circuit remains, and due to the rotation of phase which occurs because of the conditions mentioned, it is quite possible for the feedback to move sufficiently in a positive direction to set up low-frequency oscillation, or motorboating.

This position is aggravated by the inevitable coupling between amplifier stages at low frequencies via the power supply. Although high capacitance condensers bypass the HF line to ground, their reactance cannot fall below the few ohms required to give this unwanted coupling. Paper condensers are better in this respect than are electrolytics, but don't alter the fundamental difficulty, and, in any case, are too bulky to use here.

You will notice that the valves other than the output valve are fed by a separate line directly from the rectifier, which is of an indirectly heated type. This is done to avoid the coupling between the output stage and the remainder of the amplifier via the impedance of the filter choke. There is enough filtering in the decoupling circuits to remove any trace of hum in these earlier circuits. This connection is more precautionary than anything else and it would not be right to get the idea that the amplifier is fundamentally liable to motorboating. It's just a sensible way to do things.

The indirectly heated rectifier re-

PLAYMASTER JUNIOR CIRCUIT



The circuit is shown for a 15 ohm voice coil. Speakers of 2-2.3 ohms use a 1500 ohms feedback resistor. Do not omit the CT filament resistor unless a filament centre tap is used.

PARTS LIST

- 1 Chassis 9½ x 6 x 2½.
- 1 Power Transformer 285V at 80ma. 5V, 6.3V.
- 1 Filter Choke 60 or 80ma, 30H.
- 1 Output Transformer—Primary 5000 ohms, wide range type to suit speaker.
- 2 Octal sockets.
- 1 7-pin miniature.
- 1 6-pin socket.

VALVES:
6V6-GT, 6AU6, 5V4G.

CONDENSERS:
1 .05, 1 .25, 2 25 electrolytics, 1 8mfd electrolytic.
3 16mfd electrolytics.

RESISTORS, 1 watt—2 1 meg, 1 .5 meg, 1 .25 meg, 1 .1 meg, 1 10,000 ohm, 1 100 ohm feedback resistor.

RESISTORS wire wound—1 2000 ohm 5 watt, 1 250 ohm 3 watt, 1 50 ohm filament CT.

SUNDRIES:
Speaker plug and socket, hookup wire, power flex, insulated mounting strips, solder lugs, nuts, bolts, etc.

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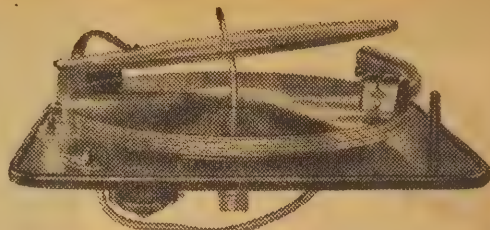

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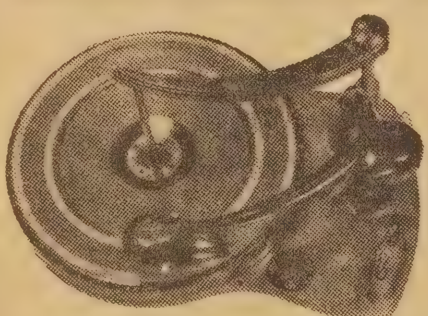

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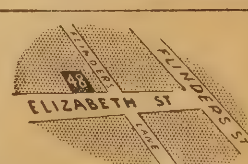
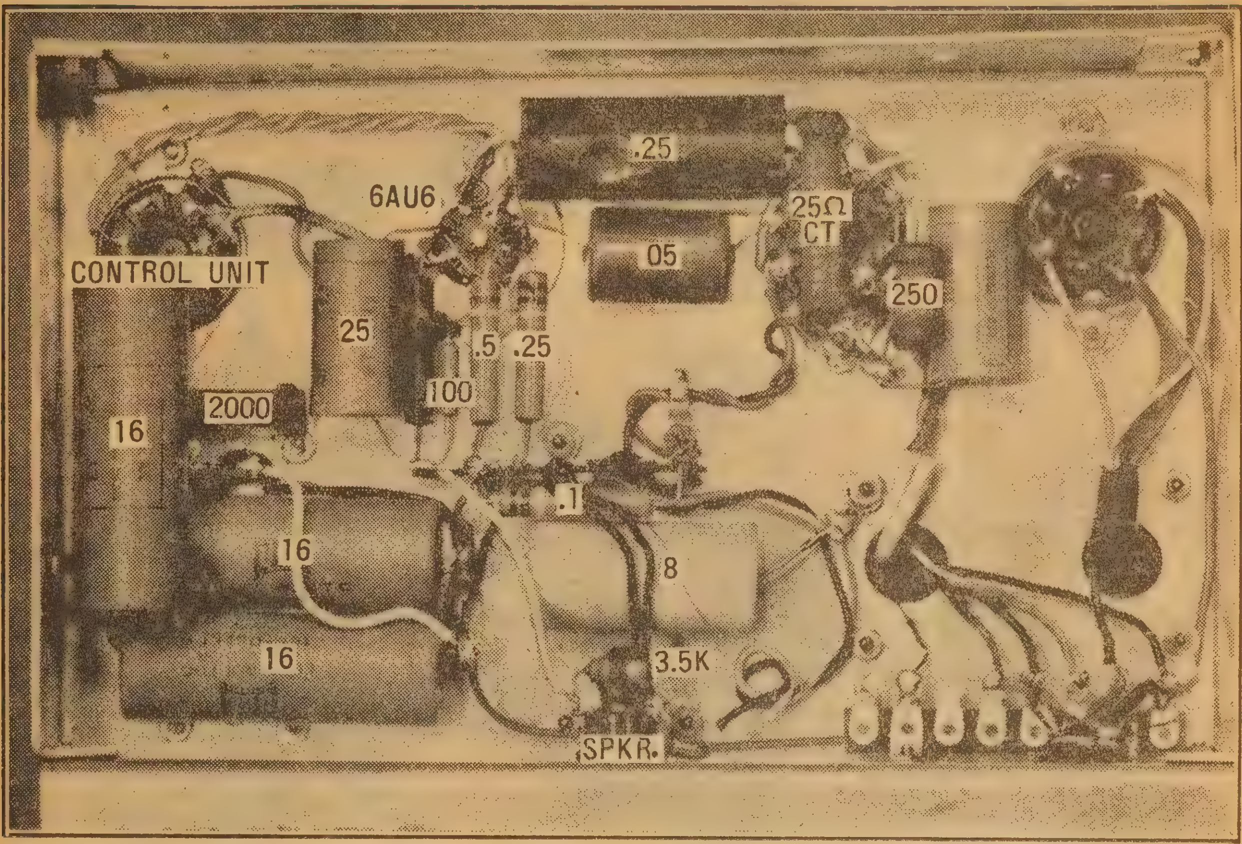


UNDER-CHASSIS OF THE PLAYMASTER JUNIOR



A few terminal strips make for clean, easy layout. Note that the 2000 ohm 5-watt dropping resistor is not mounted on the 6-pin connector socket, but is supported by a small strip.

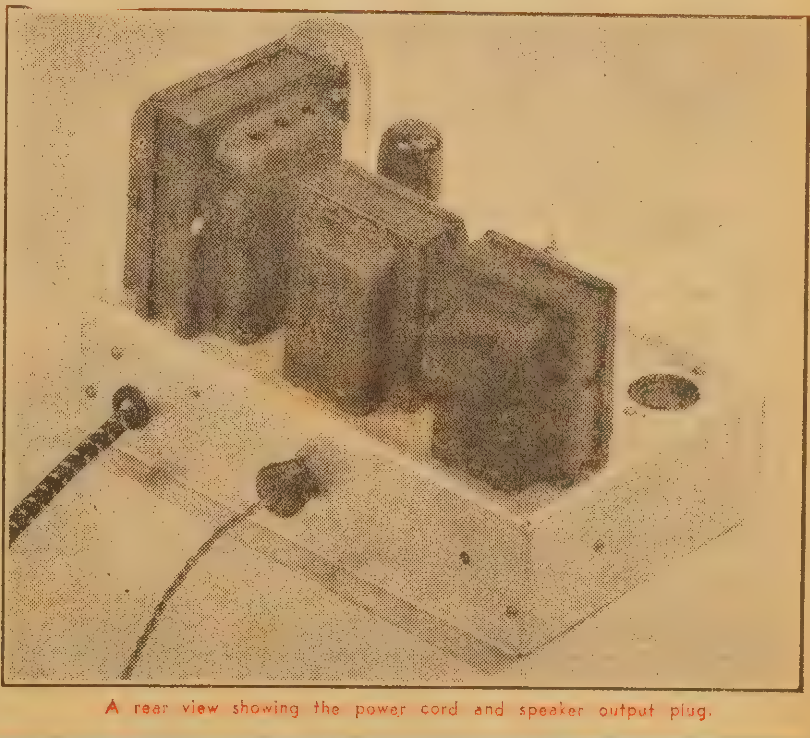
duces still further the common impedance between circuits.

In our circuit we have used a 3500 ohm feedback resistor, which, with a 15 ohm speaker, gives about 16 db of feedback, and a gain reduction of about 6-1. It is quite permissible to use a resistor as low as 2000 ohms here for 20 db or more of feedback if there is no instability. However, except for a small decrease in distortion, there isn't much point in going as far as this. Sensitivity of the amplifier is about 250 millivolts with 16 db.

FEEDBACK RESISTOR

Many of these amplifiers will be used with 2 or 2.3 ohm speakers, for which the feedback resistor should be decreased to 1500 ohms. This will give approximately the same degree of feedback and about the same overall sensitivity.

The effective plate voltage between the cathode and plate of the output valve should be about 275 volts, and the power output at 1000 cycles a little more than four watts into a resistive load. This represents a very good transformer efficiency figure and should be reached with any of the high-grade types available on the market. The PA types will not be quite so good in general performance, but with the amount of feedback used they are quite good enough to use if you have one.



A rear view showing the power cord and speaker output plug.

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In his Argument article this month Mr. Williams has made an analysis of loudspeaker damping and feedback which will show that in this matter the amplifier is just about as good as we are likely to require. It has been operated with speakers such as the 12-0, 12-0X and larger Goodmans types. On all these speakers it gave first-rate results.

Hum level should once again be quite negligible. In fact, if an extra 16 mfds condenser is connected from the rectifier cathode to ground it is virtually impossible to detect under any circumstances. So much so that on one occasion I went to bed leaving the equipment turned on, for even in the quiet house and sitting not far from the speaker (a big one in an enclosure) I just couldn't hear anything.

THE CHASSIS

The amplifier is built on the same chassis as the BABY and we have included an under-chassis picture with the components marked. There are no critical points to watch.

Note that we have used a centre-tapped filament resistor with the centre-tap connected to the 6V6-GT cathode. This is quite important unless your transformer has a centre-tap on the winding itself which can be used instead.

We spent a little time tracking-down a capacitive type of hum which was obviously being fed into the 6AU6 grid circuit from some mysterious source. It was found to be originating in the six-pin socket into which the control unit is plugged. Removing the filament leads from this socket stopped the hum, which persisted even when one of these filament pins was earthed. The coupling appeared to be due to capacitance from the filament pins to the grid pin, and persisted until, by means of the centre-tapped resistor, the filament circuit was balanced with respect to earth.

Connecting the centre-tap to the output valve cathode biases the filament circuit positively and helps to avoid any hum which might be set up particularly in the control unit due to filament emission.

Do not succumb to the temptation to mount the 2000 ohm dropping resistor completely on the 6-pin socket. If you do, you will almost certainly introduce hum into the 6AU6 grid circuit from the side connected to the rectifier. Use a small mounting strip for this resistor. The "output" end, of course, is connected to the socket, where it is bypassed by the 16 mfds. condenser.

POWER SUPPLY

The power transformer should have an 80 mill rating, but the choke may be a 60 mill type. It is good to use an 80 mill choke, as it will have a higher inductance. But the current of the tuner etc. does not pass through it, hence its lower rating. Use a 30 henry type if possible.

As a matter of fact, we used the 60 mill supply as already employed for the BABY, and even over long periods with the tuner, did not find the transformer overheating. Try the 60 mill transformer if you have one, but the 80 mill is really the job. In the upright type it will probably have the same base measurement as the 60, but be a little greater in height. In any case, the chassis should be large enough for almost any make.

(Continued on Page 63)

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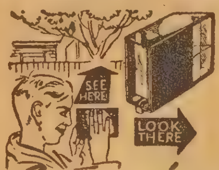

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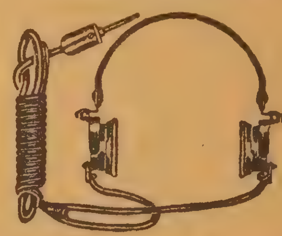

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FROM THE SERVICEMAN WHO TELLS

Last month I discussed the general layout of a typical serviceman's workshop with the promise that this month I would discuss the workbench itself in greater detail. I have also thrown in a few hints for good measure while for this month's "case" I am indebted to a reader who contributes a couple of "curly ones".

IN a passing mention of the bench last month I suggested that it should be as long as possible, both to allow more than one set to be handled at a time and also for possible expansion later in the form of an assistant serviceman.

A good approach is the allocation of a central working position, occupying some five or six feet of bench space, around which will be grouped all your test equipment and associated tools and gear. From one or both sides of this position, the bench can extend to provide that additional space which is so useful when you wish to place a set under prolonged observation without interfering with your normal routine service work.

INSTRUMENT SHELF

Your test instruments are best housed on a shelf above the bench for, if they are allowed to occupy the bench itself, they will take up valuable space, be liable to damage, as well as hard to read. On a shelf about 18 inches above the bench they will be very close to eye level and within easy reach. This shelf should extend the full length of the bench so that, when instruments are required at points other than the main working position, the same convenience will be available.

The depth of the shelf will be governed to some extent by the size of your instruments, and it is as well to keep in mind that such devices as CRO's are normally fairly long and may not be easy to accommodate on a narrow shelf. This shelf may be an actual part of the bench or it may be plugged directly into the wall.

Power for the instruments can be taken from a series of outlets beneath the shelf, with each socket preferably having its own switch. A similar group of outlets should be located at one or two strategic points along the bench to handle instruments which may temporarily be "away from home." It is probably a good idea to keep all your "extra" power outlets mounted on the bench, the latter being regarded as an "appliance" which is plugged into the main outlet.

TOOL RACK

For this and other reasons it is a good idea to fit a back to the bench, extending possibly the full length and reaching as high as the shelf. As well as serving to mount the power sockets for the test instruments it is about the most convenient spot for a tool rack or shadow board and the judicious use of nails, screw-eyes and small hooks will provide that "place for everything" which is so essential during periodic clean-ups.

If all this available space is not used, it is also a good spot to mount handy data charts such as resistor color codes (I still need one of these for values over five!), broadcast station frequencies, &c. If these can be protected with a sheet of celluloid, so much the better.

If your equipment boasts a universal speaker, it is as well to arrange the location of this in such a way that the speaker section at least is available for close listening, thus making the checking of hum and other elusive noises a simple matter. A large speaker mounted on an efficient baffle and hanging somewhere up near the ceiling may give excellent reproduction but hardly of a representative type and, in addition, it makes the checking of hum rather difficult.

Under the bench is a handy spot for drawers, say three on each side and leaving a central clear space to allow you to sit at your bench if you so desire. These drawers may be used for service spare parts such as resistors, condensers, valves, &c., which you will need in your everyday work. They can be quite distinct from your main stock which you may keep in the shop proper.

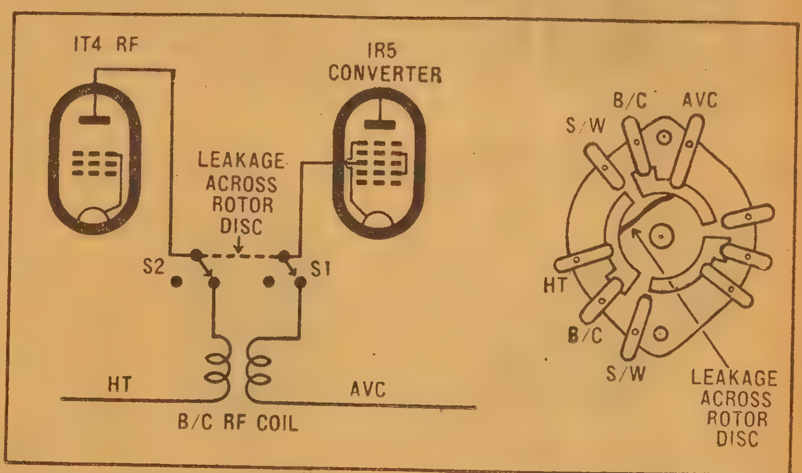
"Issues" from the main stock can be made at regular intervals to avoid nibbling at your main stock, one item at a time. This "nibbling" process makes it difficult to keep accurate stock records.

It is probably well worth while to set aside a complete drawer for each of the major items, such as resistors, condensers, and valves, and each may be subdivided so that the items may be classified according to their values.

Another very useful item on a test bench is a turntable and pickup. The latter need not be a high-class job, just so long as it is reliable and you have a fair idea of its characteristics. This is handy for testing radiogram chassis or for any form of testing which needs an audio signal. There is the added attraction that it may take the form of either music or tone.

The work bench is hardly the place for such a unit, for it will collect dirt and be subject to quite a lot of knocking about when the bench becomes crowded.

A better idea is to fit one of the top drawers with a false bottom and mount the turntable and pickup in that. Thus the unit will be out of the way when not required, but may be quickly brought into a convenient operating position, simply by opening the drawer. The power and pickup leads may be taken out the back and arranged so that they may be readily disconnected and the drawer removed for use elsewhere, say the PA system, if required.



This circuit shows how the faulty wave change switch caused HT voltage to be applied to the AVC line. On the right is a sketch of the wafer showing the leakage path.

Remaining drawer space may be used to accommodate many of those odd items which always seem to accumulate around a test bench, but which can only be classified as "miscellaneous." Which brings me to the point that there are quite a lot of miscellaneous items, which every serviceman should have, but which often appear to be overlooked when thinking in terms of the more expensive equipment. Usually they are quite small items, but they can make quite a lot of difference to the amount of time you spend on a job, and, hence, the amount of money you make on it.

A test lead which breaks in the middle of a sticky job can be most annoying for, by the time you have repaired it, your train of thought has been interrupted and a certain amount of time lost as a result. Spare

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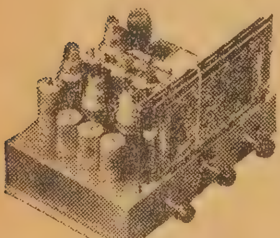

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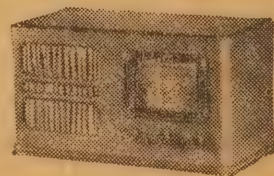

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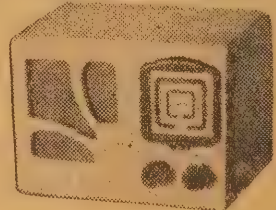

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sets of leads for multimeters, oscillators, and universal speakers will enable you to keep on with the job and leave the repair of the damaged unit until a more convenient time.

Test leads made from ordinary hook-up wire are seldom satisfactory, being far too stiff and liable to breakage. Commercial test leads usually employ wire specially designed for this class of work and which is known as "extra flexible."

This characteristic may be obtained in several ways, the two most popular being the use of a very large number of fine strands (as many as 150 at about 40 gauge), and the use of metal tinsel wound on a core of cotton threads similar to the old-time headphone cords, though perhaps a trifle heavier. In either case, the results are very satisfactory and breakages will be much less frequent.

CLIP LEADS

Although not readily available in bulk, it is worthwhile trying to use something of a like nature when making test leads for your own gear.

Another very useful form of lead is the double clip lead, consisting of about 12 inches of wire, preferably "extra flexible," with an alligator clip at each end. A handful of these can save much valuable time when it is necessary to make temporary connections which hardly warrant the use of an iron.

In addition to sets having almost every conceivable type of power plug, as already discussed, there are quite a few fitted with chassis plugs and having a socket on the end of the power cord. It is not unusual to have these delivered to the shop without the cord, the owner having failed to realise the importance of it, and thus one is forced to improvise some kind of connection.

A selection of cords with typical chassis sockets fitted will save a lot of time, as well as removing the temptation to use a "haywire" connection, with its possible danger to life and limb. (Pardon me if I sound gruesome!)

A serviceman should build up a comprehensive library of such books as service manuals, valve data booklets, &c., as well as straight-out textbooks which cover the servicing angle. A small section of the shelf can be set aside for these and you will find that you can save much valuable time by knowing the right reference and having it ready to hand.

BATTERY SETS

In country areas there are battery sets to be handled, both of the dry battery variety and the vibrator type. It is most unusual for the batteries to be brought in with the chassis and it must be assumed that in most cases you will have to supply your own power.

Most dry battery sets operate from 90 volts HT and 1.4 volts for the filament, although some older sets use a 2-volt accumulator and 135 volts of HT. Probably the best idea is to set aside either two or three 45-volt blocks and a 1.4 volt block, tuck them away under the bench, where they will be safe and out of the way, and wire them to convenient terminals on the back of the bench. If three blocks are used tappings can be provided for both 90 and 135 volts, thus making available either one, two or three blocks, as required.

The placing of the terminals should be such as to minimise the risk of short circuits, but, in any case, the old idea of a miniature lamp type fuse is still quite a good one and can protect both the batteries and valve filaments.

POWER PACK

An alternative suggestion is a small power pack to supply HT and this will certainly save the cost of batteries. However it is important that such a unit perform in a similar manner to that of the actual batteries, particularly in the matter of internal resistance, if it is to give a truthful indication of the performance of the set in the field.

For the vibrator sets you will require an accumulator, six volts being by far the most popular for this class of set. It, too, can be tucked away in an odd corner and wired to the bench but it is most important that the additional wiring does not add any appreciable resistance to the circuit, otherwise vibrator hum will become very pronounced.

Some vibrator sets operate the filament circuit from the two volt tapping of the battery (to avoid using a series parallel arrangement) and to accommodate these a two volt tapping should be provided on the bench. This tapping will also supply the two volt required for battery type sets already mentioned. All accumulator circuits should be adequately fused to avoid the possibility of serious damage, perhaps a fire, in the event of a short circuit.

The use of an accumulator implies that a charger will be available, and this is really essential in a country district quite apart from the needs of your test bench. Charging of customers' batteries is a service you will be expected to provide and if properly conducted can result in a small but steady profit.

BATTERY CHARGER

Just how large your charger will need to be will depend entirely on the size of your business, but you can always start with a small unit and add a larger one at a later date and, having your charging facilities spread over a number of units, is often very convenient.

The alignment adjustments which you will encounter will present quite a variety, including the normal screwdriver slot, the hexagon head, and the small shaft with two parallel flats milled on it such as is found on the miniature types. Having the correct tools to fit these is most important, as attempts to improvise with a pair of pliers or the like is very time-consuming, as well as running the risk of damaging the screw, or whatever it is, to the point where the correct tool will no longer fit it.

As time goes on you will find that there are many such points to be observed, if a job is to be done in a minimum of time, but the foregoing will help you get some idea of what is required.

And so much for that for the time being!

For my case this month I am referring to a letter which has been passed on to me by the Technical Editor from a fellow serviceman, Mr. K. L. McG., of Eidsvold. Mr. McG. lists two faults which he considers are sufficiently unusual to warrant describing for the benefit of other servicemen. "Strangely enough," he says, "both these faults occurred in the same receiver, which is a 1949 model of one of Australia's most popular makes."

The set was a 5-valve dual-wave battery model employing 1.4 volt valves and the first fault took the form of intermittent oscillation, which could often be cured by retuning the set. Mr. McG. at first discounted any association of the retuning symptom with the actual fault and proceeded to check all the usual causes of such faults, such as soldered joints, bypass condensers, and even a replacement of valves but without success.

BAD ROTOR CONNECTION

"Finally," says Mr. McG., "the possibility of the rotor shaft of the tuning condenser not being properly earthed presented itself and, on touching a screwdriver from the can of the first IF transformer to the condenser shaft, the instability disappeared like magic. Certainly the manufacturers had not overlooked fitting contact wipers for this same purpose but it was found that they were unreliable, so an old style wiper from a set of prewar vintage was salvaged and fitted in place of one of the new wipers, with 100 pc satisfactory results."

The next time the set had to be serviced it was again intermittent, but this time it turned out to be a valve which had prematurely given up the ghost, an occurrence which Mr. McG. does not seem to regard as anything unusual in the 1.4 volt series, though he admits that they are improving somewhat. (You'd know more about that than we "city slickers" Mr. McG.)

Anyway to get on with the story. Although the replaced valve was obviously the cause of the intermittent the set was extremely weak and a preliminary "once over" failed to reveal any obvious cause. Delving deeper into the mystery our friend finally reached the point where he was checking voltages with a VTVM and eventually came to the AVC line which, quite naturally, he expected to show a slight negative voltage.

POSITIVE AVC

"Putting it mildly," he continues, "I was surprised to find that, not only was there a complete lack of negative voltage on the AVC line, but that the VTVM indicated a good deal of positive voltage in this circuit, considering the way in which the meter indicated well off scale in the wrong direction. On switching to a positive reading on the VTVM it was found that there was actually 3 volts positive in place of the zero or negative volts at first anticipated."

To aid his explanation from here on, Mr. McG. enclosed a rough sketch of the relevent portion of the circuit and the editor has had this redrawn for publication. You will see that it involves the RF and converter section and, in particular, the RF BC/SW coil switch, it being to this spot that Mr. McG. finally traced the elusive 3 volts. By now, it had become 40 volts, because the grid of the converter valve (IR5) had been disconnected (along with lots of other wires) and, with the drain caused by grid current removed, the voltage had risen substantially.

Eventually, all leads to one section of the switch were disconnected but the 40 volts positive was still present on the two active contacts and the moving contact (marked S1 in the drawing). However, when

Q-PLUS
AC 1
MIDGET B/C AERIAL COIL
"SPHEROCLAD"

FREQ. COVERAGE — 520 — 1600 Kcs.

TUNING CAPACITY — 25 — 445 uufd. (Inc. strays)

PHYSICAL SIZE—¾" x ¾" x 1⅜".

PIN CONNECTIONS—
- P = Aerial.
- B + = Earth—primary.
- F = Earth—secondary.
- G = Grid.

MOUNTING—3/16" whit nut onto moulded insert in base—template supplied.

PRIMARY INDUCTANCE—1.65 mH.

SECONDARY INDUCTANCE when tuned to 1000 Kcs.—210 uH.

APPROXIMATE GAIN at 600 Kcs.—5 times.

SECONDARY "Q" at 600 Kcs.—100.

REMARKS

Construction is of 9/41 litz wound secondary with Hi Z primary designed to match about 14 feet of indoor aerial. Coupling of approximately .2 is maintained by gauged fibre washers. Top coupling is not included but may be added externally by means of about a 5-8 uufd. condenser between P & G terminals.

Earthing of can is accomplished by folded can lugs, care should be taken to see that sprayed chassis are cleaned at these points before assembling.

R. W. STEANE & Co. Pty. Ltd. Auburn, Vic.

SUBJECT TO CHANGE WITHOUT NOTICE.

Q-PLUS
AC 2
MIDGET B/C CAR TYPE AERIAL COIL
"SPHEROCLAD"

FREQ. COVERAGE — 520 — 1600 Kcs.

TUNING CAPACITY — 25 — 445 uufd. (Inc. strays)

PHYSICAL SIZE—¾" x ¾" x 1⅜".

PIN CONNECTIONS—
- P = Aerial.
- B + = Primary Earth.
- F = Secondary Earth.
- G = Grid.
- A2 = Secondary Tap.

MOUNTING—3/16" whit nut onto moulded insert in base—template supplied.

PRIMARY INDUCTANCE—1.45 mH.

SECONDARY INDUCTANCE at 1000 Kcs.—210 uH.

APPROXIMATE GAIN at 600 Kcs.—8 times.

SECONDARY "Q" at 600 Kcs.—100.

REMARKS

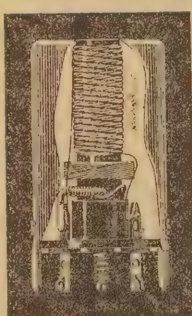
Construction is of 9/41 litz wound secondary with Lo. Z primary designed to match can type aerial and coax lead. Hi Secondary Q is obtained by use of Carbonyl Iron Dust Cups. Secondary is tapped and it is recommended that a 100 uufd. condenser be placed between P & A2 to complete correct coupling. Earthing etc. (see AC1).

This unit is specially designed for car radios or other midget sets, with small or High "C" component aerials.

R. W. STEANE & Co. Pty. Ltd. Auburn, Vic.

SUBJECT TO CHANGE WITHOUT NOTICE.

Q-PLUS
AC 4
STANDARD GENERAL PURPOSE B/C COIL



FREQ. COVERAGE — 520—1600 Kcs.

TUNING CAPACITY — 25—445 uufd. (includes strays)

PHYSICAL SIZE—1⅜" diam. x 2¼".

PIN CONNECTIONS
- 1—Grid.
- 3—AVC.
- 4—Aerial.
- 6—Earth.

MOUNTING—2 x ⅜" holes, 1⅜" apart.

PRIMARY INDUCTANCE—1.65 uH.

SECONDARY INDUCTANCE when tuned to 1000 Kcs.—210 uH.

APPROXIMATE GAIN at 600 Kcs.—6.5 times.

SECONDARY "Q" at 600 Kcs.—110.

REMARKS

This unit is of the progressively wound type 7/41 litz wire is used and a moderately high gain and "Q" is achieved. It is a good general purpose unit when high gain is not called for. Has inbuilt top coupling condenser.

R. W. STEANE & Co. Pty. Ltd. Auburn, Vic.

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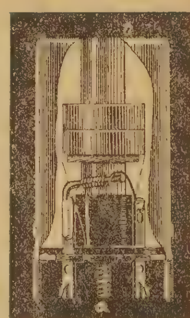
Q-PLUS
AC 5
STANDARD HIGH GAIN B/C AERIAL COIL
"SPHEROCLAD"



FREQ. COVERAGE — 520—1600 Kcs.

TUNING CAPACITY — 25—445 uufd. (includes strays)

PHYSICAL SIZE—1⅜" diam. x 2¼".

PIN CONNECTIONS—
- 1—Grid.
- 3—AVC.
- 4—Aerial.
- 6—Earth.

MOUNTING—2 x ⅜" holes, 1⅜" apart.

PRIMARY INDUCTANCE at 100 Kcs.—1.65 uH.

SECONDARY INDUCTANCE when tuned to 1000 Kcs.—210 uH.

APPROXIMATE GAIN at 1000 Kcs.—10 times.

SECONDARY "Q" at 600 Kcs.—176.

REMARKS

Construction is of 9/41 Litz wound in special carbonyl pots giving extremely high "Q" and gain. High Z primary is designed to match about 14 feet of aerial. Coupling is approximately .25. An inbuilt top coupling condenser of 5 uufd. is used to increase high frequency power transfer.

R. W. STEANE & Co. Pty. Ltd. Auburn, Vic.

SUBJECT TO CHANGE WITHOUT NOTICE.

the HT was removed from the adjoining switch section (S2) the unwanted voltage vanished, indicating a leak across the insulating material of the switch.

FAULTY SWITCH

Probing the matter still further, our friend forced a gap between the moving and fixed contacts, which removed the offending voltage from the latter while it remained on the former, thus establishing that the leak was across the small rotor disc in the centre of the switch which carries the moving contact.

The exact cause of the leakage must, it seems, remain a mystery, for apparently there was no visible evidence to indicate just why it did what it did. However, what I think is the most interesting part of the story is that of two tests which Mr. McG. conducted on the defective rotor.

First he endeavored to measure the leakage with the high ohms range of the VTVM which, he points out, is capable of measuring up to 1000 megs but, to use his own words, "the needle would not even flicker." Next he measured the current flow between the switch contact and chassis and found it to be in the order of 20 microamps, or as near to that figure as could be measured on a 1 mA scale.

Now these two tests are in direct contradiction one of the other, for the second test indicates a leakage in the order of four or five megohms which should have been readily indicated on the 1000 megohm scale.

FAILURE OF TEST

It is things like this, of course, which lead to arguments about the theory versus practice and the like, but our friend probably indicates the cause of the discrepancy when he points out that the first test was, as he calls it, a "cold" test, that is, only a very low voltage was applied across the leakage and was, apparently, insufficient to cause a breakdown. With the full HT voltage applied, however, it was a very different story and the leak became one of relatively low resistance.

The moral?

Only, I think, that every piece of test gear has certain limitations and, while in this case the measurement was only made as a matter of interest, such limitations can give rise to misleading results if one is not "awake up" to them.

As to the cause of such a leakage one can only guess. A scrap of foreign matter in the material from which the rotor was punched; the ingress of moisture; or too liberal an application of soldering flux during wiring—your guess is as good as mine, or Mr. McG.'s, though personally I am inclined to pitch for the last theory.

The presence of a thin film of paste between two points of differing potential has been a cause of trouble on more than one occasion and, as far as I can establish, the process goes something like this. After a time the film of paste collects a layer of tiny dust particles, the type which are so fine that it is almost impossible to keep them out of anything, and these in turn absorb moisture. The moisture forms a high resistance path through which there is a minute flow of current, and this reduces the dust particles to a form of carbon, increases the conductivity, and so the whole thing becomes a vicious circle with the carbon track getting heavier and heavier until the insulation breaks down completely.

Although the leak is originally through the dust film it is not long before the insulation itself is affected and I have seen a meter switch wafer reduced to a charred mass when something like 1000 volts was applied between two contacts so affected. In the case of a battery set, it sometimes happens that the HT voltage is not disconnected when the set is switched off and the slow disintegration continues 24 hours a day.

Mr. McG. established that the leakage could be prevented by forcing a small space between the metal moving contact and the insulating material in which it was mounted, but he very wisely regarded this as a temporary measure, more to confirm the location of the fault than anything else, and effected a permanent cure by completely replacing the offending wafer. I say wisely, because one cannot be certain about curing a leak of this kind, and the risk is too great when a client's satisfaction, and hence your reputation, is at stake.

And just to finish things off, I have a little "Believe It or Not" story. Actually I can vouch for its authenticity because it was a personal experience, but I can hardly blame you if you find it a little hard to swallow.

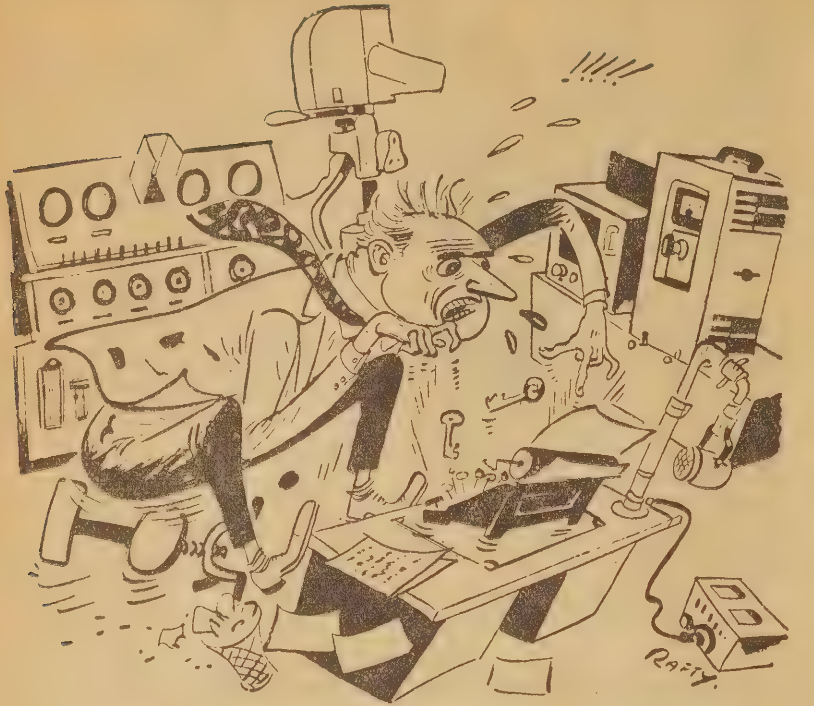
The set was a very old one. You'll get some idea of how old when I list the valve types as a 27 regenerative detector, 27 audio amplifier (transformer coupled), and a 45 in the output. The fact that such a set was still going was something to be wondered at, anyway, but the really choice bit was still to come.

ANCIENT RELIC

The reasons for my services being sought were twofold. First, the set was very weak, and secondly it was far more partial to one station than any other, spreading it from one end of the dial to the other. The cause of this second effect was easy—the station concerned had recently moved from its original location on the other side of the city to a new spot less than a mile away.

I explained that there was not very much that could be done with such a simple set, although I did discover that there was already a wave trap of a kind connected in the aerial circuit and by setting it to

(Continued on Page 100)



the cone to cycle to a stop on its own initiative.

The resulting train of damped oscillations, occurring at the bass resonant frequency, tends to impart a distinctive "thumping" quality to staccato sounds. Some of the older speakers I remember had a resonance like the gong in a Chinese temple. In the current, better quality models, it is often quite difficult to pick.

An accepted method of analysing a speaker's performance in this connection is to feed it with a train of low frequency square waves and either observe the voltage across the voice coil or by electrostatic pickup from a scrap of metal foil cemented to the cone.

EFFECT OF RESONANCE

The effect is as illustrated in figure 1, where the applied driving voltage would ideally take the form suggested by the solid line.

In practice, the cone will take an appreciable time to accelerate from the original position "x" to the crest of the square wave, so that the wave front will lean slightly.

However, having been accelerated, the cone will tend to overshoot, then subside to the correct position in the manner illustrated by the dotted line.

At this point, we could get involved again in an earlier argument about the integrating or differentiating action of speakers, &c. Let's stick to conventional diagrams, how-

Let's Buy An Argument

Loudspeaker damping has been, for many years, one of the classic subjects for discussion among amplifier fans. With some it has become almost a fetish. Unfortunately, I fear, many such have inadvertently swallowed several camels while straining at the proverbial gnat.

by W. N. Williams

NOW don't get me wrong. I'm not suggesting for one moment that loudspeaker damping should be dismissed forthwith as a consideration of amplifier design. I certainly do suggest, however that its value be assessed on a more realistic basis.

Let's have a down-to-earth chat about the whole thing. Forgive me if it doesn't sound much like an "argument," although it might easily start one.

The question of damping would not arise at all if only we could concoct a speaker cone from some magic weight-less plasticine, which would move only at the bidding of the signal and do absolutely nothing of its own accord.

As it is, a practical speaker cone must have a certain amount of weight and it must be supported by an elastic medium, which will return it always to a central position in the pole structure.

Possessing mass and compliance, the cone assembly of necessity exhibits a frequency of natural resonance. It may range from as high as 200 cps for a small speaker to as low as 20-odd cps for special designs.

At the resonant frequency (1) the speaker normally shows a rise in output for a given input. Furthermore (2) if the cone is displaced from its "at rest" position and then let go, it may oscillate through a number of cycles at the resonant frequency before finally coming to rest.

While these observations are closely related, number (2) is the one we're immediately concerned with.

Plenty of signals occur during the normal course of sound reproduction which sharply displace the speaker cone, then cease abruptly, leaving

ever, and avoid confusion of a second order.

With a narrow transient, as in 1b, the "overshoot" and resonance effects might well produce the kind of result illustrated in 1c. The possible coloration of all reproduced sound with the speaker's own characteristics is evident.

To emphasise the point, one experimenter I read of, selected a whole series of typical speakers and baffle systems and arranged them in ascending order of resonance. He then proceeded to play a recognisable tune by exciting the cones in turn with a simple DC pulse.

While this might be all very interesting, no speaker should thus be allowed to call its own tune—which is where the whole question of damping comes in. Let's proceed!

When the amplifier is actually driving the cone, the equivalent circuit is as shown in figure 2a. The amplifier is the generator and the speaker is the load in which the power is dissipated.

The moment the speaker begins to oscillate freely, however, the positions are reversed. The speaker becomes the generator, because its voice coil is oscillating of its own volition and cutting the lines of force in the magnetic gap. The power thus generated (or diverted) is dissipated in the output circuit of the amplifier.

You can't really separate the two functions in terms of time, because both will be occurring simultaneously. The speaker will be the load for the audio power actually fed to it from the amplifier, but the amplifier will constitute the load for all power generated (or diverted) by simultaneous "overshoot" and freewheeling actions of the cone.

CONE LOADING

To minimise the freewheeling action, it is necessary to load the cone by mechanical means (suitable speaker design and baffling) and/or by the electrical means with which we are now concerned.

If the amplifier, for example, can be made to have a low output resistance, the energy generated by the cone acting as a generator will be quickly dissipated and the cone will come to rest. Actually, this works out very nicely in practice and gives the triode fans cause to rejoice.

Let's do a couple of sums.

Push-pull 2A3's have long been the basis of a favorite type of amplifier. Two of them in class A operate into a load of 5000 ohms P-P. If they happen to be feeding a 15-ohm voice coil, the output transformer would need to have an impedance ratio of 330:1.

Looking back the other way, the voice coil "sees" the output impedance of the 2A3's (800 plus 800 ohms), but stepped down by the same ratio. This is equal to 1600/330, equals 4.8 ohms.

In other words, when the 15-ohm voice coil decides to do a spot of freewheeling and generating on its own account, it finds virtually a 4.8 ohm resistor clamped across its terminals and ready to dissipate its energy in double quick time.

SAME RATIO

Had we decided to work out the constants for a 2.0 ohm voice coil, we would find that the output transformer had a impedance ratio of 2500:1. The amplifier output impedance at the secondary now gets down to 1600/2500 or 0.64 ohms.

It becomes obvious from the above that the significant figures are not the individual impedance values, but rather the ratio which holds between the two. The ratio is constant for a given set of operating conditions, irrespective of whether it is summed in the primary or the secondary circuit. It is independent of the voice coil impedance.

It is therefore completely wrong to assume, as some have done, that a 15-ohm voice coil will be damped more effectively than a 2-ohm voice coil or vice versa. If the output transformer ratio is optimum in both cases, the damping factor will be constant.

Damping factor, by the way, is taken to be the ratio of the load impedance to the amplifier source or output impedance, the two values being referred to the same point in the circuit. Thus the damping factor

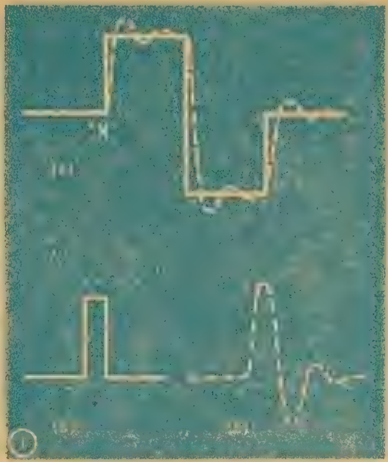


Figure 1. Illustrating the way in which poorly-damped cone resonance effects turn angular waveforms and transients into a series of damped wave trains.

for the 2A3 amplifier just mentioned would be a little over 3.1.

This is a fairly typical figure for straight triode amplifiers. Even though the plate resistance figures of other valves vary widely from the 800 ohms quoted for the 2A3, it is usually found that optimum load figures vary in the same direction, so that the damping factor is not greatly affected.

Pentodes and tetrodes, on the other hand, show up badly by comparison, the damping factor of a straight 6V6 being less than 0.1 under typical conditions.

Nowadays, it is almost universal practice to apply voltage negative feedback to pentode and tetrode amplifiers, the result being a very drastic reduction in effective output impedance.

I use the term "very drastic" quite deliberately because there seems to be considerable misunderstanding about the exact effect of feedback on output impedance.

In two books I have come across recently appears a statement that the output impedance of an amplifier is reduced approximately in the same ratio as the gain reduction factor.

This would be rather disheartening to the exponents of negative feedback, because it infers that a gain reduction of 33 times or 30 db would

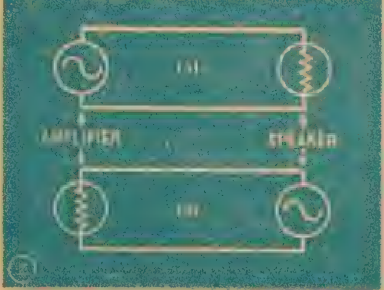


Figure 2. The speaker isn't always the output load. When the speaker cone tends to "freewheel" or "overshoot," the roles are reversed.

be necessary to bring a 6V6 into line with a 2A3!

In actual fact, this approximation applies really to the reduction in the net parallel impedance of amplifier output and load. This puts a very different face on to things Let's work it out.

The parallel impedance of a 6V6 and its output load is 52,000 and 5000 ohms, equals 4500 ohms.

If the 6V6 is to have a damping factor of 3, as for a triode, its effective output impedance must be reduced by feedback to 5000/3 equals 1660 ohms.

The parallel resultant of this new output figure and the 5000 ohms load is now 1250 ohms.

Applying the approximation I mentioned earlier, the gain reduction required would be 4500/1250 or 3.6 times, equivalent to 11 db. This is actually very close to the exact figure.

In a recent issue of Electronics, R. M. Mitchell of the United Transformer Company devises a very simple formula for the effect of voltage negative feedback on the actual output impedance:

Df equals F (Do plus 1) minus 1

Where: Df is the damping factor
F is the number of times by which the gain is reduced
Do is the damping factor without feedback

Now that isn't hard to work out. However, remembering that initial damping factors for triodes and tetrodes work out almost invariably at about 3.0 and 0.1 respectively, the expression boils down to:

Df equals 4F minus 1 (for triodes)
Df equals F minus .5 (for tetrodes)

Mitchell has prepared a set of curves, which I reproduce showing the relationship between damping factor of both triodes and pentodes with varying amounts of feedback applied.

The curves indicate that a gain reduction of between three and four times is necessary with a tetrode to achieve the same damping factor as a straight triode. Furthermore, that triodes will always be better than tetrodes in this respect for a given gain reduction factor.

The Williamson amplifier is shown to have a damping factor of 27, which looks like nine times better than a straight triode amplifier.

At this stage, a few folk may be rubbing their hands in glee and registering an expression which clearly means "I told you so." But hold hard . . . that's not the end of the story.

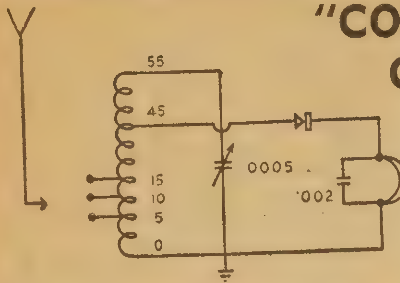
Just how much damping is required to prevent the dreadful things we illustrated in figure 1?

HOW MUCH DAMPING?

Back in May, 1950, J. Moir published in Wireless World a series of oscillographic patterns which indicated visually the behavior of a speaker cone excited by square-wave pulses. Tracings of the patterns are shown in figure 3.

In 3a the damping factor is about 0.1, as for a pentode, and the free oscillation of the cone is most marked.

A damping factor of 1.0 in 3b has greatly reduced the overshoot and oscillation, while the effects are completely absent in (c) with a damping factor of five. Moir's conclusion is that a damping factor of two will eliminate most of the undesired



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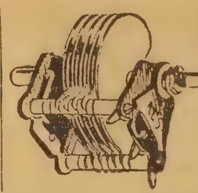

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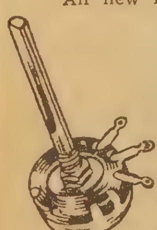

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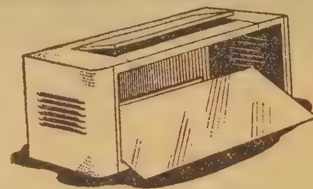

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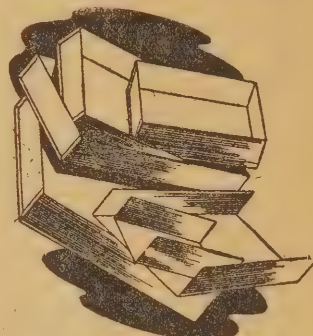

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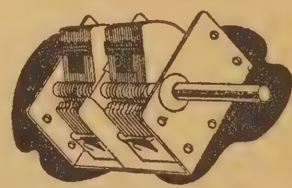

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effects but it can be increased with advantage to about four or five. There is no practical advantage in striving for a figure greater than this.

His conclusion is based both on the oscillographic patterns mentioned and on a mathematical analysis, by which he deduced the amount of loading which had to be imposed on the speaker to achieve "critical damping."

"Critical damping" occurs, by the way, when the voice coil is loaded by a value just sufficient to prevent free oscillation.

Referring these findings to familiar circuits, the majority of Radio and Hobbies receivers and amplifiers have been designed in the past to use tetrodes with about 10-12 db of feedback applied. This has ensured a damping factor at least equal to and generally better than straight triodes.

In the more recent "Playmaster" series, the feedback has been increased up to about 20db, giving a gain reduction of 10 times and a damping factor well above the critical value for current speakers.

But I can well imagine the reaction of some who will contend thus: Why stop at a damping factor of 10 when you can push it up to 20 or even 30?

DON'T MEAN MUCH

The figures sound impressive but, in actual fact, they scarcely mean a thing.

You see, figure 2b doesn't tell the whole story, because it merely shows the output impedance of the amplifier shunted across the voice coil. Presumably, if the output impedance were reduced to zero, any independent motion of the voice coil would produce an infinitely large current through the shorting circuit.

Such is not the case, for the current would be limited by an internal resistance of the voice coil winding itself—and this can amount to 70 or 80 pc of the nominal coil impedance.

Therefore, we must re-draw figure 2b to include the series resistance Rs and we get the diagram of figure 4.

Now let's take a typical case with one of our "Playmaster" amplifiers feeding into a 15-ohm speaker. We can expect Ro to have a value about 1.5 ohms while Rs will be around 12 ohms. The total resistance in the loading circuit, which is going to determine and limit the loading current, is 13.5 ohms.

If we substitute a "sooper-dooper" amplifier, triodes, feedback and all that, Ro will drop to say 0.5 ohms and the total resistance in the circuit to 12.5 ohms.

The improvement in actual damping will not be two to one or three to one or anything like it. Rather is the ratio 13.5/12.5 which is equal to 1.08 to 1. Even if the amplifier could be given zero output impedance, the improvement would still only be little better than 1.1 to1.

NOT FANTASTIC

The idea of having an amplifier with zero output impedance may seem fantastic, at first glance, because it would ostensibly mean that you would be developing volts across a short circuit. Actually there is no such difficulty.

Consider the case of a triode having a comparatively low output impedance. It takes virtually no energy to vary the plate current from the

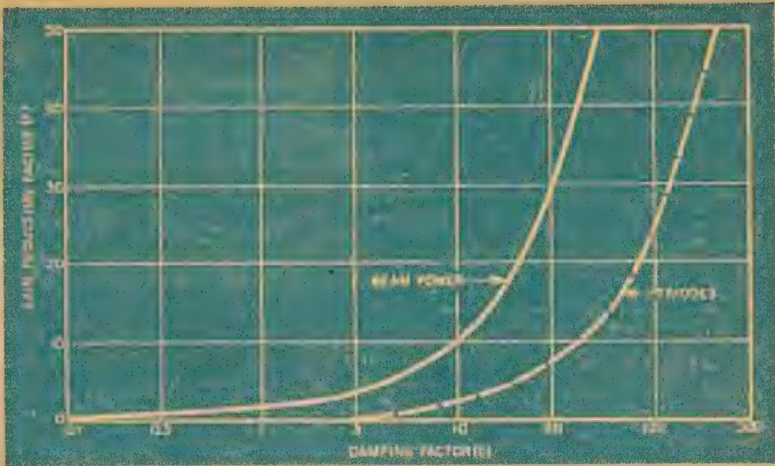

Figure 5. Damping factors of pentodes and triodes with increasing feedback. Voice coil resistance renders the difference in most cases insignificant.

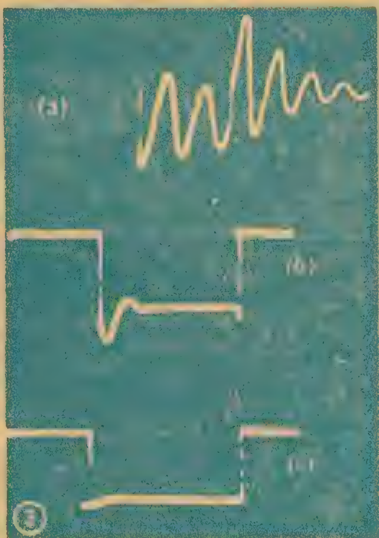

Figure 3. Tracings of actual voltage waveforms measured across the voice coil of a speaker. (a) is undamped electrically, (b) is partially damped and (c) is heavily damped.

signal end, because the function is performed by the grid.

Looking back from the load end, however, an extraneous variation in plate voltage (due to vagaries of the load itself) will result in a sharp variation in plate current, because of the low plate resistance. The product of this voltage and current represents an appreciable power loss, which serves to damp the speaker.

Should an amplifier have zero output impedance, it simply means that the slightest tendency for a voltage to be fed back from the load would result in an infinitely large decrement of plate current and an infinitely large power dissipation. It thus becomes virtually impossible for the speaker to generate any voltage at all across the output circuit.

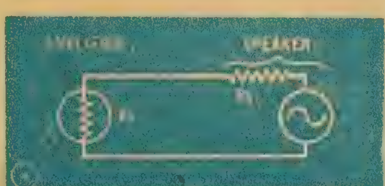

Figure 4. For proper assessment of damping factor, the voice coil's own DC resistance must be taken into account. Unless negative resistance damping is attempted, there is little practical point in reducing Ro below 20 pc of Rs.

TABLE 1

Type of Speaker	D.C. Resistance of Voice Coil	Critical Damping Resistance
High-quality 17in unit	9.0 ohms	2.5 ohms
High-quality 12in unit	9.0 ohms	2.0 ohms
Cheap 7in (Make A)	8.2 ohms	1.2 ohms
Cheap 7in (Make B)	1.5 ohms	0.6 ohms
Cheap 7in (Make C)	11.5 ohms	4.7 ohms

TABLE 2

Speaker Mounting	Source Impedance for critical damping.
1. Open on bench	8 ohms
2. In 2500 cubic inch box	2 ohms
3. In short horn	12 ohms

Table 1. (by J. Moir) shows critical damping values for a selection of speakers. Table 2 shows damping values for the same (presumably 15-ohm) speaker with different baffling. Line 2 suggests that the "Q" of the box is higher and requires more damping than the speaker itself.

This, however, does not prejudice the ability of the grid to control the plate current in the normal way. The zero output impedance holds only when looking back at the plates from the load end.

A somewhat different approach is necessary for a feedback amplifier but the final result is the same.

As a matter of fact, recent work overseas has been directed to obtaining an effectively negative output impedance by the use of feedback.

It has been shown that positive current feedback tends to reduce output impedance just as does negative voltage feedback. Conversely, both positive voltage feedback and negative current feedback tend to increase output impedance.

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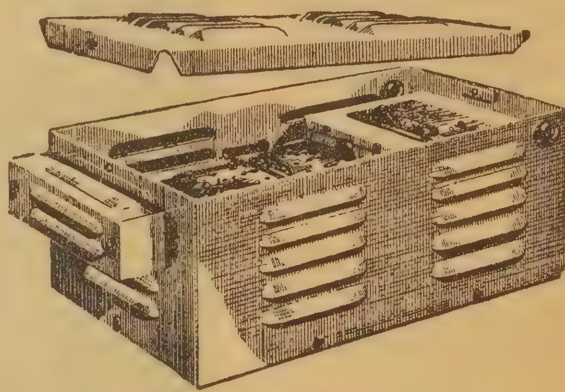

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Making use of these facts, amplifiers have been constructed using a large amount of negative voltage feedback, resulting in low impedance and low overall gain. A positive current feedback loop is then added—something like 6 db—which restores the gain to the required figure, leaves enough negative feedback operative to ensure low distortion but drives the output impedance into the negative region.

With such an amplifier, the audio output voltage declines when the load is removed and what might look like a positive surge of voltage from the load (due to overshoot, &c.) actually produced a negative surge from the amplifier.

SOME COMPLICATIONS

Such a characteristic allows complete electrical damping of a speaker, because the negative resistance of the amplifier cancels the "positive" (or conventional) resistance in the voice coil.

It all sounds very interesting, but a few points have to be watched. The damping requirements of individual speakers vary, in that one having a "springy" cone assembly and/or low flux density in the gap is harder to damp than one having high flux density and/or a cone suspension which is inherently well damped mechanically.

If too much negative resistance is used, its effect may simply be to turn the oscillatory wave train upside down.

Another point is that varying the output impedance of an amplifier does affect the acoustic output from a speaker, as distinct from the mere voltage measured across the voice coil.

It does not necessarily follow that a speaker gives the most level output, plotted against frequency, with a constant voltage across the voice coil. Some do better with a constant current through the coil.

It is not at all impossible, therefore, that the provision of an extremely low or a negative output impedance may degrade the treble response to the point where preliminary compensation will have to be added elsewhere in the amplifier. It all depends, but it's worth thinking about!

But even ignoring this problem, one must remember that damping can control for certain only the major bass resonance of the cone assembly.

Other resonance effects, along the surface of the cone, remain blissfully unaffected because they may never be communicated to the voice coil. They remain purely as a function of the speaker design and the method of baffling.

One other point I must make by way of conclusion, namely that the average small listening room is likely to exhibit a half-dozen or more modes of low frequency oscillation, each one similar to but more serious than the bass resonance of a reasonably damped speaker. It's silly to go grey about the one and ignore all the others.

So there it is! Damp your speaker by all means—up to a point. After that it might be a lot more profitable to turn yourself into a carpenter and start messing around with dividing walls and better baffles.

A Latin quotation would be appropriate at this point, but I can't think of one suitable.

BEAT NOTES &c.

The discussion of beat notes and combination tones, a couple of months back, apparently provided much food for thought, to judge by the correspondence.

I had to change the subject, however, because it was becoming so complex and specialised that more and more readers were being left out in the cold. I may wake it up again later, depending on circumstances.

In the meantime, it has become clear that a great deal of doubt, speculation and controversy lies dormant beneath the glib definitions in many text books. If the authors were clear in their minds, their readers certainly are not.

I am indebted to a Western Australian reader for a lengthy mathematical analysis in which he condemns as a universal fallacy the idea that the beat occurs at the difference frequency. He suggests rather, that the beat is equivalent to a note intermediate in frequency between the two original tones, but modulated 200 per cent at half the difference frequency. The inversion of the modulation envelope effectively doubles the stimulus frequency.

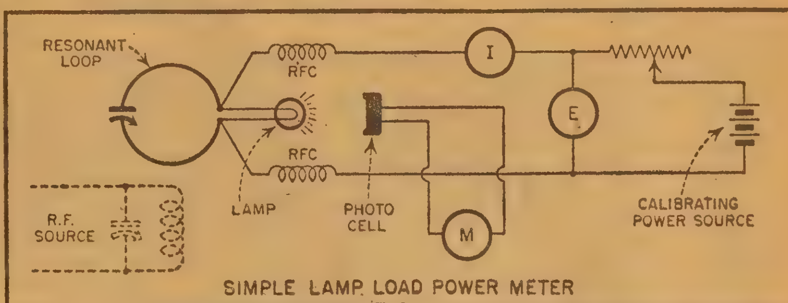
This thought may be worth a lot to others who haven't been able to fit the original frequencies into the role of sidebands.

DATA ON UHF POWER MEASUREMENT

Although the methods used to measure the r.f. power output of ultra-high frequency oscillators and amplifiers differ considerably from the techniques employed at lower frequencies, they are in some respects more direct and accurate.

MOST of these methods convert the radio frequency energy to be measured into heat in a resistive material and then compare some manifestation of this heat with an equal effect produced by an easily measured d.c. or low-frequency a.c. power.

Thus, such systems are self-calibrating, and are limited in accuracy only by the extent to which the incident power is totally absorbed in the lossy material, the sensitivity of the power indicating means, and the precision with which the calibrating power is substituted and measured.



SIMPLE LAMP LOAD POWER METER
FIG. 1

GENERAL TYPES

The general types of UHF power meters may be classified according to which manifestation of heat is employed. The three most frequently used are:

(a) Lamp loads (light).
(b) Bolometers and thermistors (resistance change).
(c) Calorimetric loads (temperature rise).

Because of the individual characteristics and limitations inherent in each of these methods, their use is generally confined to different fields of UHF power measurement. These characteristics and special applications will be considered here.

At the low frequency end of the UHF spectrum, the power delivered by a signal source may sometimes be measured by using it to light the filament of one or more incandescent bulbs and then measuring the amount of power from a known source required to produce the same illumination.

A photoelectric cell or photographic exposure meter is usually used to indicate the relative light intensity.

LAMP LOAD

Fig. 1 shows the essentials of a typical system using a lamp load. The lamp is connected in series with a resonant L-C circuit coupled inductively to the r.f. power source. The calibrating a.c. or d.c. power is connected to this circuit through r.f. chokes which prevent the leakage of r.f. power into the calibrating circuit. The calibrating power source should be variable and metered by a watt-meter or voltmeter-ammeter combination.

Power measurement by lamp loads is usually limited to frequencies below 1000 megacycles/second by radiation losses, and by the fact that the filament in which the power is dissipated must be short compared with the wavelength of the power being measured. Otherwise, standing waves will exist on the filament, with corresponding variations in brightness.

Power measurements are also limited to the range of powers which can produce incandescence in a filament. This range is from several hundred milliwatts to several hundred watts.

At best, power determinations by lamp load methods are capable of only fair accuracy and so are used principally for quantitative measurements with open-wire circuits.

Most conducting materials, including all metals, exhibit a resistance change when heated. This property is utilised in a family of devices known as "bolometers" and "thermistors" to make accurate power measurements over a wide range of power and frequency. Typical constructions are illustrated in Fig. 2.

The temperature sensitive element is hermetically sealed in a glass bead, or capsule, and fitted with connecting leads. In the case of the bolometer, the element is a fine platinum wire

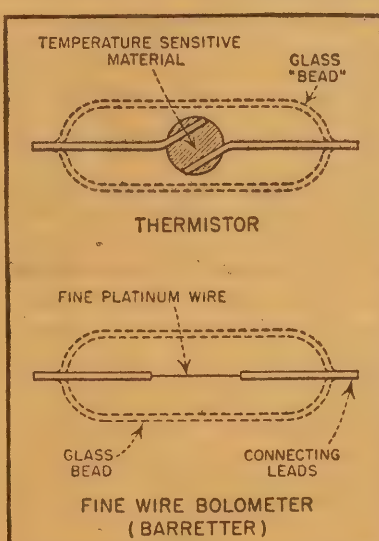


FIG. 2

only a few ten-thousandths of an inch in diameter. Another name for such devices is "barretters."

The element in thermistors consists of a compound of metallic oxides fused between the connecting leads. The resistance-temperature coefficient of thermistors is negative rather than positive, as in the pure-metal bolometers, and is numerically larger. Thermistors are therefore capable of somewhat greater sensitivity, as well as exhibiting better overload characteristics.

In measuring power with temperature sensitive elements of this type, the transmission line carrying the power is terminated in the bolometer or thermistor so that all incident power is dissipated in the temperature sensitive element. The resulting temperature rise causes a corresponding resistance change in the element, which is also connected to form one arm of a Wheatstone bridge circuit, as in Fig. 3.

A BRIDGE

This bridge is usually balanced prior to the introduction of the r.f. power, so that the resistance change in the thermal element causes an unbalance current which is directly proportional to incident power, to flow in the meter.

The actual r.f. power is determined by measuring the amount of a.c. or d.c. biasing power which must be subtracted from the bridge circuit to re-balance it. Bridges used in this manner are called "balanced bridges."

The bridge may also be used as an "unbalanced bridge" by assuming that the meter deflection is linear with power, as it is when used within the power ratings of the element, and calibrating it against a balanced bridge at one or more points.

By the nature of their construction, temperature sensitive elements of the bolometer and thermistor type are limited to the direct measurement of low power.

ACCURACY

Very accurate power determinations are possible in the range between one microwatt and several milliwatts. This range may be extended to very much higher power levels through the use of attenuators or directional couplers of known attenuation.

To achieve good accuracy with bolometer or thermistor bridge measurements, all of the incident power must be dissipated in the thermal element. In other words, the resistance of the

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AN EXPLANATION: *It has been brought to the attention of Magnetic Sound Industries that their Public Announcement in last month's issue of "Radio and Hobbies" may have been misunderstood. The intention was merely to point out that some customers have found difficulty in constructing home recorders from parts, owing to lack of technical knowledge. We have, therefore, stopped selling separate components and in future Magnetic Sound Industries will continue to sell only assembled recorders.*

PYROX TAPE RECORDER

In last month's issue the price of the Pyrox Tape Recorder was inadvertently printed as **£134/10/-** and should read at **£135/8/4.**

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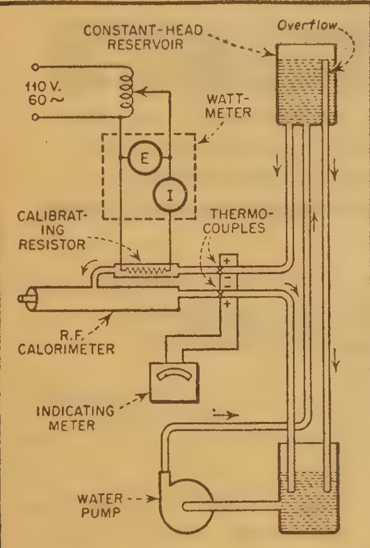
element must match the impedance of the transmission line at the frequency of the incident power being measured.

Methods have been evolved of mounting elements of this type in both coaxial and waveguide transmission lines so that a good match exists over bandwidths of at least 50 pc. Examples of typical "broadbanded" thermistor mounts are shown in Fig. 4. A standing wave indicator is usually used in conjunction with such mounts to measure the degree of match existing between the line and the load.

Since the resistance of the thermal element varies with temperature, it may be made to present a better match by adjusting the bridge current flowing through it.

The third type of UHF power meter which is in common usage is the calorimeter or "water load." In this method, the power to be measured is absorbed in a column of water, or other liquid which circulates through a section of the transmission line. The power dissipated in the liquid results in a temperature rise which is measured by thermometers or thermocouples and is directly proportional to the r.f. power.



COMPLETE WATER LOAD SYSTEM

FIG. 5

If the liquid used is water, and the rate of flow and temperature rise are known, the power may be calculated by:

(1) $$\text{Average power (watts)} = 4.18\, F \Delta T$$

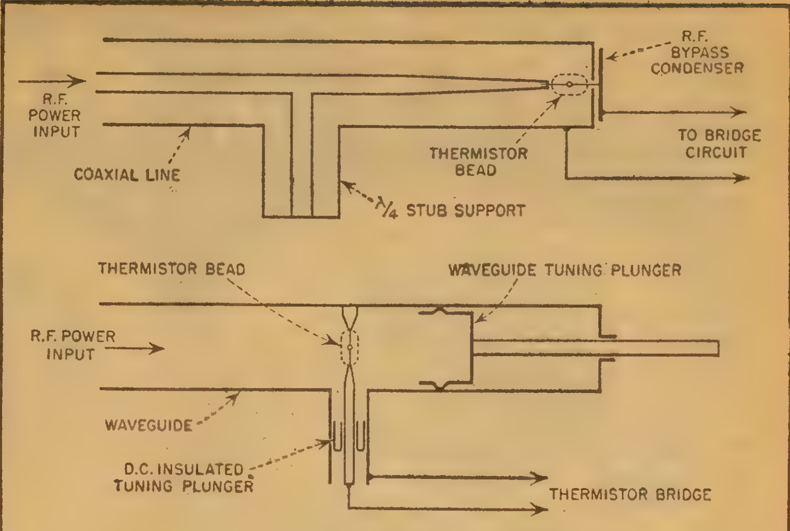
Where: F is the flow rate in cubic centimeters/sec.

ΔT is the temperature rise measured. (Degrees C.)

This calculation is eliminated in some modern calorimetric systems by resorting to power substitution. For this method no knowledge of the rate of flow is required, although a constant rate must be maintained.

A diagram of a system of this type is given in Fig. 5. The transmission line is terminated by the calorimeter load. Water flows through this load at a constant rate, as determined by the constant-head reservoir.

A pair of temperature indicating devices, such as thermometers or thermocouples, are mounted in the



TYPICAL THERMISTOR MOUNTS

FIG. 4

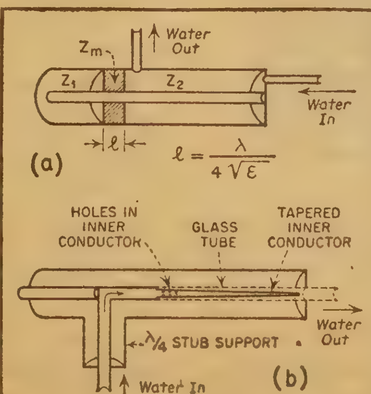
water stream near where it enters and leaves the calorimeter. An a.c. or d.c. calibrating load resistor is also mounted between the points of temperature measurement, which are arranged to indicate the temperature *rise* between them.

In the case of thermocouples, this is done by connecting the "cold" and "hot" junctions in opposition. Thus, the meter reads zero until there is a temperature increment due to heat in the r.f. or a.c. loads.

To measure power with this water load, the meter deflection is noted with the r.f. source turned on. This power is then removed and an equal deflection is produced by substituting low frequency calibrating power in the load resistor. If the thermal conditions for the load resistor are similar to those of the r.f. load, the calibrating power required to produce the same deflection will be equal to the r.f. power and can be read directly from the wattmeter.

The errors in this system can be reduced to a very low minimum. The water flow is usually selected so that the temperature rise is only a few degrees above room temperature, thus minimising errors due to heat radiation from the water tube.

Another possible error arises from the fact that heat produced in the r.f. load undergoes additional losses in flowing through the calibrating resis-

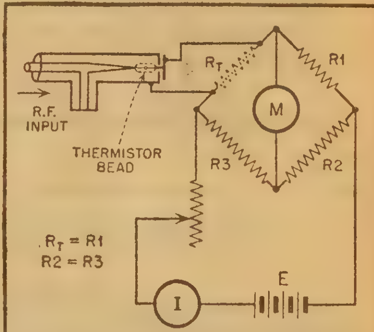


TYPES OF COAXIAL WATER LOADS

FIG. 6

tor, or conversely, depending on the direction of water flow.

This error could be virtually eliminated by mounting the resistor in the same place in the calorimeter that the r.f. power is absorbed. However, for reasons of impedance matching

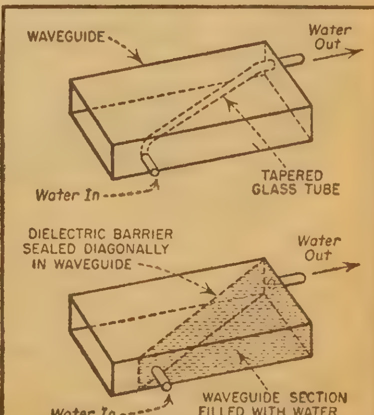


SIMPLIFIED THERMISTOR BRIDGE

FIG. 3

which will be discussed later, this is usually impractical.

A reasonable compromise can be had by designing the load resistor in two parts so that half of the calibrating power is substituted on each side of the r.f. calorimeter. In this manner half of the calibrating power



TYPES OF WAVEGUIDE WATER LOADS

FIG. 7

HOW MUCH VOLTAGE WILL YOU GET

When it comes to deciding just how many volts will appear at the output of a power supply, many readers are out on the proverbial limb. Let's look into the matter to see what is required to enable you to perform this seemingly arduous task.

THE basic necessities are a valve data book containing operation characteristic curves of receiving type rectifier valves and a piece of paper and pencil. Use a slide rule if you like but it's hardly necessary.

Main facts which need to be considered are:—the type of filter (whether capacitor-input or choke input), the type of rectifier, the DC resistance of the filter choke or chokes, an approximation of the current drain of the set, and whether back-biasing is employed.

We will take a sample case to illustrate the whole precedure. Suppose we have a 285 volt a side secondary winding on the power transformer, a 5Y3-GT rectifier and a set which takes roughly 80 mA drain. A rough assessment of the current drain can be made by adding to the cathode current of the power output valve about one half to two-thirds of the static current of the other valves, remembering that AVC action will reduce the static current of the RF and IF valves. Total static currents can be obtained from valve data sheets.

Turn to the page in the valve data book giving characteristics for the full-wave operation of a 5Y3-GT into a capacitor-input filter. You will see that there is a curve for different levels of voltage to each plate ranging from 150 volts to 500 volts in 50 volt steps. Each curve is roughly the same shape and slopes the same way as the others.

These curves are plotted against "DC load mA" along the bottom of the page and "DC output volts to the filter" up the left hand side of the page.

USE OF CURVES

Selecting the 80 mA point along the bottom scale, transfer this point, by running up the line, to the curve representing the secondary voltage of the transformer between one side and the centre-tap. In this sample case the figure of 285 volts a side calls for interpolation between the curves for 250 volts and 300 volts.

This interpolation is done either by eye or by counting the squares vertically between the two curves and dividing them accordingly to the relationship of the transformer voltage to the two curves. In this case, we have 35/50 ths of about 13 squares which equals about 9 squares. Remember that this is only approximate, as the curves are not exactly equi-distant.

From the point found on the vertical 80 mA line, move at right angles towards the left hand scale where you will find that approximately 290 volts is the "DC output volts to filter".

Discounting for the moment the possible use of back-bias, all we have to do is to subtract from this figure the voltage drop across the DC resistance of the filter choke.

You can obtain this DC resistance figure either by measurement with an ohmmeter or by reference to the catalogue of the particular brand of choke you are using. Taking a nominal figure of about 350 ohms, the voltage drop across this for a current drain of 80 mA will be equal to 80 times 350 divided by 1000. This gives a drop of 28 volts, which, when subtracted from the 290 volts at the output from the rectifier, leaves about 262 volts to appear across the last filter capacitor.

Assuming the use of a 6V6-GT in the output stage operating with nominal bias of 12.5 volts, the voltage between the screen and cathode of this valve will be 262 volts minus the 12 odd volts of bias developed across the cathode resistor. This leaves just on 250 volts, the screen voltage rating for the valve under these conditions.

REDUCING VOLTAGE

If the output voltage is higher than you desire, it will be necessary to insert a wirewound resistor in series with the filter choke. The value of the resistor can be calculated by dividing the excess voltage by the current drain and multiplying by 1000. A resistor could be inserted between the output of the rectifier and the first filter capacitor to give the same effect but its value is a little more difficult to calculate. As a matter of interest, though, a value of about one half that calculated for the position in series with the choke usually works out close to the mark.

If back-bias is employed in the transformer centre-tap, the drop across this resistor should be added to the drop across the choke in obtaining the voltage appearing across the last filter capacitor.

The rectifier curves are drawn for a certain value of first filter capacitance. For larger values, the output voltage will be slightly higher. This is in order except when the rectifier is running on the border of its ratings.

Another point mentioned on the heading of the curves sheet is "plate supply impedance." Usually, the lower current rating transformers supply sufficient series impedence within the windings for normal operation within the ratings. Where the transformer current rating is high and it is used with low impedance type rectifiers such as the 5V4-G, it is usually necessary to insert resistors of about 50 to 100 ohms in the connection to each plate.

Where a choke-input filter is used, the appropriate rectifier curves are used in the manner as for the "capacitor-input" curves. The DC resistance of the choke or chokes is subtracted from the output voltage as before. It must be remembered, however, that the rectifier output voltage will be much lower than for similar conditions with the capacitor-input. Choke-input filtering is used in special applications.

DATA ON UHF POWER MEASUREMENT

(Continued from page 49.)

experiences less. Thus the error tends to average out.

In the design of calorimetric power absorbers, several requirements must be met. The water column must be a good impedance match over the frequency range, so that all power is absorbed. The volume of liquid heated must be large enough to dissipate the power to be handled, but must not be too large; otherwise the response will be very sluggish.

Fig. 6 shows two designs which have been used with coaxial lines. The load illustrated at 6a makes use of a quarter-wave dielectric bead transformer to effect an impedance match between the air-filled line and the water-filled section. The impedance of the bead section must satisfy the familiar condition for quarter-wave transformers:

$$Z_m = \sqrt{Z_1 Z_2} \quad (2)$$

Where: Z_m is the impedance of the matching section

Z_1 is the impedance of the air-filled line.

Z_2 is the impedance of the water-filled section.

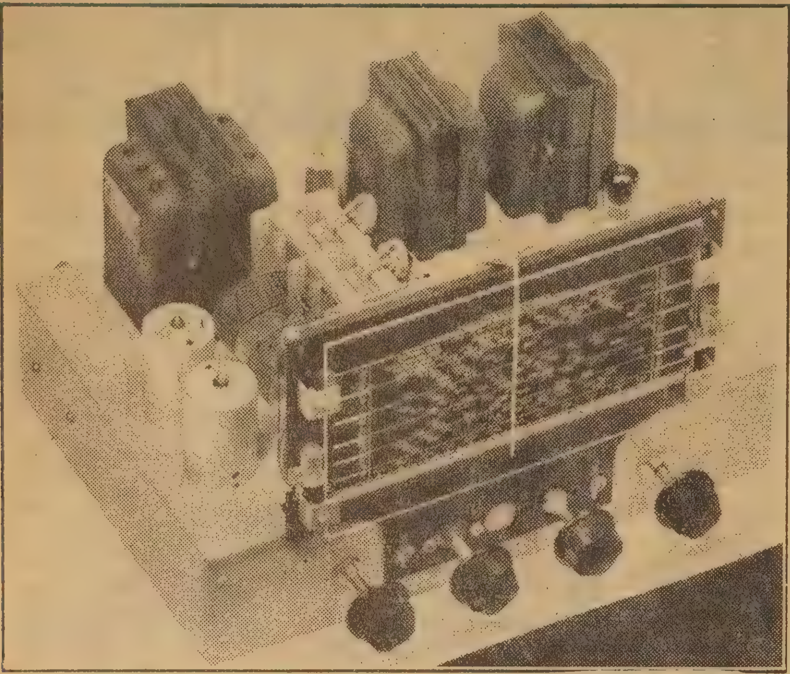
This is achieved by selecting a material for the bead which has a dielectric constant of about 9, which is the geometric mean between that of air (1) and water (about 81).

The load depicted in Fig. 6b is effective over a greater bandwidth than the quarter-wave transformer type discussed above. This is because impedance matching is done gradually by tapering the water column rather than introducing it abruptly. The centre conductor of the load is gradually replaced by the water stream. The water is introduced through the stub support, which is the only frequency-sensitive element in the load.

Two types of water calorimeter loads which are used with waveguide transmission lines are shown in Fig. 7. The kind which employs a glass water tube diagonally across the guide is usually preferable because of less thermal lag.

Water loads are useful as power indicators over the range of several watts to several thousand watts. They are not generally applicable to lower power measurements.

undergoes more losses than the r.f. produced heat while the other half



A front view of the Advance 1952. Controls L to R are Tone, Tuning, Selector and Volume.

tion and a wide band-width, and often we have occasion to listen to signals over a distance. If not in a big city, we must have reasonable gain and selectivity to get a change of programme.

Now some time ago, Neville Williams described a tuner using an ingenious switch circuit which changed one of the intermediate coupling circuits to resistance coupling for a wide-range listening position. There was still one IF transformer in circuit, but the extension of bandwidth, which resulted, was quite enough to make a pronounced difference on good programmes. Sensitivity naturally dropped a little, but not more than could be made up by turning the volume control a notch higher. As the original tuner had an RF stage, it really wasn't necessary to do even that—the AVC almost took up the difference.

WIDE-RANGE

Now that's one bright idea which has stood the test of time. We have used it once or twice in other circuits, and I still have the original tuner operating at home. It always intrigues me to hear the band open out when the switch is clicked. If not quite as good as a TRF tuner, it's a mighty big improvement!

And it's not at all hard to wire in. Only a few extra components

ADVANCE 1952 RADIOGRAM

This, our first receiver for the New Year, is a real beauty! It's a high performance, 5-valve radiogram incorporating variable selectivity for wide-range reception, and correct compensation for all types of gramophone records. One switch does the lot! And if you wish, you can build it with a standard short wave coil bracket to include short waves.

by John Moyle

IT is just twenty years since the first advance set was described in Wireless Weekly, forerunner of Radio and Hobbies. It was a straightforward TRF set incorporating all the best features of the day. Thousands of Advances were made up and built in factories, and to my knowledge some of them are working to this day.

Every now and then we have described other Advance receivers following in the tradition of the first design—simplicity, efficiency, and up-to-date practice.

A "DIFFERENT" SET

For 1952, however, we have broken away from many practices which have been standard in the past, and have designed for new conditions and new demands.

The 1952 Advance relies for its performance on ideas which have grown up in various circuits we have published in recent times. They have been incorporated because each had something to give in making a set capable of providing the kind of reception demanded by the informed listener of today.

This new set is different because it is the first to appear which does satisfy that demand, and may well set a new style.

Perhaps the biggest influence on a modern radiogram is and will continue to be the microgroove record—both long playing and short playing. It has brought to radio stations, and to the home, a new standard of reproduction. For the first time, we are really able to hear and appreciate wide range music without having to make any allowances for high scratch level and restricted range. Whereas to date only the specialised few have thought it worth while to chase wider range, it is now of great importance to any listener.

The severely lopped, top register which accompanies the average superheterodyne is sending us back to the TRF Receiver—not far removed from the old Advance—for wider range reception, and it's probably the best all-round solution of them all.

But the TRF set does carry with it some disadvantages for the average man. It isn't very sensitive, nor selective if designed for local recep-

and a switch. We'll hear more about that switch in a moment.

Another good point about this method of wide-banding is that the circuit remains essentially a superhet, and can be used for dual-wave reception by using a standard dual-wave coil bracket in place of the broadcst coils of this set. There is plenty of room under the gang, and the connections are the same except that they run to the coil bracket instead of the individual coils.

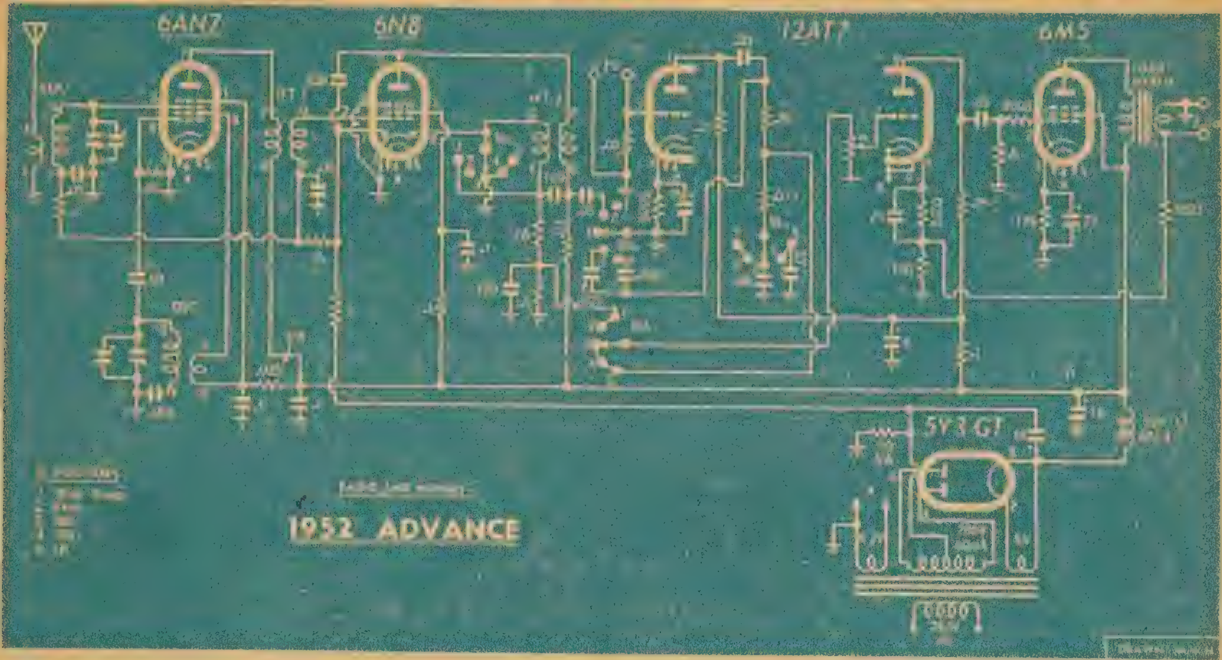
This, then, satisfies the first requirement of today's receiver—it should be able to hear programmes—particularly wide-range microgroove records — with an extended upper register.

RECORDS

The second requirements concerns playing records, for no general purpose receiver today is worth considering unless it can be used as a radiogram.

Now the best way to consider modern record playing is to refer back to some of the articles on the PLAYMASTER amplifiers which have been designed especially for them. And we find in the PLAYMASTER BABY described last month just the thing we want for the audio stage.

CIRCUIT DIAGRAM OF 1952 ADVANCE RADIOGRAM



Don't be fooled by all those switches — the circuit is really quite simple. Feedback resistor is 1500 ohms for 8 ohm voice coil and 2500 ohms for 15 ohm coil.

If you look at the circuit of this set, you will see that the audio end uses a beam power output valve driven from one half a twin triode for radio, and from both valves for records. The first half is wired as a pre-amplifier which provides the correct bass and treble compensation for 78 British and American records, in addition to LP or microgroove.

This selection of record compensation is made by a single switch.

To simplfy things completely, in the new Advance, this same switch is used to change over to radio, either normal or wide range.

Thus all the requirements of our modern radiogram have been brought to a single selector knob with five positions. With a modern, lightweight pickup permanently connected in circuit, this switch does everything you need for any type of listening.

This is possible by the use of a little thought and with a two-bank, 2 x 5 wafer switch.

Section S1 short-circuits the secondary of the second IF on wide-range radio, and earths the detector diode on all three pickup positions to prevent any radio reception being audible when playing records.

SWITCHING

S2 provides a bypass condenser for the .02 resistor in the normal position, and removes it in the wide-range position so that it may operate as a plate resistor, coupled to the diode circuit by the .0001 condenser. In the pickup position, this switch brings in the treble cut condensers from the plate circuit of the triode pre-amplifier, thus doing two jobs, one for radio and one for records.

S3 is effective only in the pickup positions, and switches in the correct value of bass-boost condenser. S4 is the section which changes from radio to records.

To connect all thse leads to the switch makes the circuit look a little filled up, but it's not in the least complicated. If you follow our layout, you will find that the necessary connections can be made with short leads, and without crowding. There is nothing critical about it —we just wired up the original set, switched it on, and it worked! You should be able to do the same.

Describing the circuit in general, we have a straightforward converter and single IF stage at 455 kc. using two high performance valves in the 6AN7 and the 6N5. The latter is the IF amplifier, and the diodes are used for detection and AVC. In the interests of simplicity, the bias for these valves comes from a back-bias resistor which provides 2 volts minimum bias. Despite the high gain valves, these is no oscillation in the set. Should you be so troubled, increasing the back-bias resistor to, say, 50 ohms, is an easy way to avoid it.

The diode load is composed of the .05 and .5 resistors in series. In the normal position, the 100 pf "coupling" condenser becomes a diode bypass to earth in series with the .05

PARTS LIST

1 Chassis. (advance 1951).
1 Tuning dial.
1 2 gang tuning condenser.
1 2 bank 2x5 switch.
2 Broadcast coils, aer. and osc.
2 Trimmers
2 455Kc I.F. Transformers (Nos. 1 and 2).
4 Noval sockets—1 octal socket.
1 Power transformer, 285V at 80 mills, 6.3V, 5V.
1 80 mill, 30H Filter Choke.
1 Output transformer, 5000 ohms to V.C.

VALVES—6AN7, 6N8, 12AT7, 6M5, 5Y3.

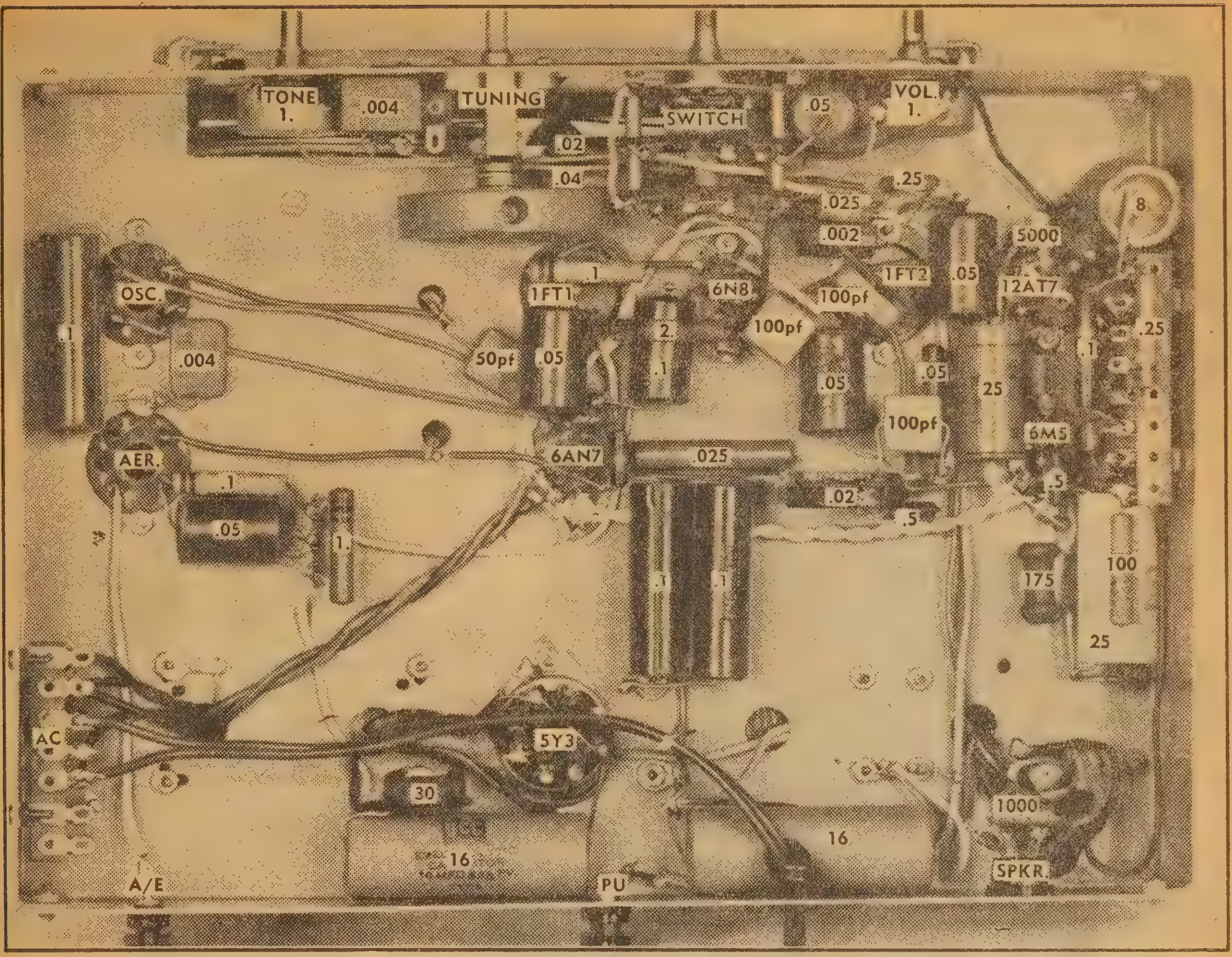
CONDENSERS—

2 16mfd 525V electrolytics.
1 8mfd 525V electrolytic.
3 25mfds 40V electrolytics.
3 .1mfds. 400V.
5 .05mfds 400V
1 .04 mfds 200V
1 .02 mfds 200V
1 .004 mfds mica
1 .002 mfds mica
1 .001 mfds mica
3 100pf mica
1 50pf mica

RESISTORS—

2 1 meg pots
1 2 megs
1 1 meg
2 .5 megs
3 .25 megs
2 .1 megs
3 50,000 ohms
2 25,000 ohms
1 20,000 ohms
3 5000 ohms
1 1000 ohms
1 175 ohms 5W
1 100 ohms
1 30 ohms 5W

Speaker plug and socket, terminal strips, four knobs, power flex, nuts, bolts, four terminals dial lamps. hookup wire, etc.



Nearly all components are visible here. Others are discussed n the text.

condenser. From the junction of these two resistors, a lead runs to the change-over switch.

The twin triode valve used is the 12AT7—a new, miniature valve which until now has been very hard to get. However, we have been assured that ample stocks will be available this month. It is almost exactly the same as the ECC35 or 6SL7 we used in the Playmaster equipment, and this valve could be used if you have it.

SENSITIVITY

The use of a triode to drive the output valve means that the audio section is somewhat less sensitive than would be the case if a pentode were used instead, but in practice this really means that the volume control is normally used a little further advanced. The more conventional pentode-beam-tube circuit really has much more sensitivity than can generally be used, and, in fact, quite a few receivers these days use diode triodes instead of diode pentodes. In any case, our high gain RF and more than makes up for the difference.

The same inverse feedback circuit is used as for the Playmasters. This circuit feeds back portion of the voltage developed across the voice coil into the cathode circuit of the triode stage, reducing distortion (and gain) and lowering the effective output impedance of the 6M5. Without repeating what has already been said about the Playmasters, there is about 15 db of feedback which can be considered to reduce distortion to a very small figure—probably no more than 1 pc or less at normal volumes.

A good output transformer is recommended for this set, as for the amplifiers, although a PA type will operate quite well.

It is not normal now to supply speakers with transformers attached, and if you have one so fitted you would do well to discard it. As regards speakers, this set deserves a good one, and even a 12-inch imported high quality type isn't too good. At any rate, we are assuming that it will be used with a 12in. speaker. Suitable output transformers can be obtained in several brands and in the normal impedances of 2.3, 8, and 15 ohms.

We use this method of feedback because it includes the entire amplifier within the loop, and can be used with any output impedance merely by changing one resistor value. It also avoids any difficulties in hum suppression.

In fact, the set has a particularly low hum level, and in this connection is much superior to many receivers selling at the present time. Obviously a good filter choke is advised, and we have specified a 30 henry type.

The sensitivity of the amplifier in the pick-up position is about 150 millivolts for 4 watts output—ample for the average lightweight and plenty for a crystal. A crystal pick-up should be connected through the circuit given herewith. In this connection, we refer you to the article on crystal pick-ups which appeared in the November issue.

The 6M5 output valve is used primarily for its high sensitivity, which makes it particularly suitable following the triode driver. Don't forget the grid suppressor — always advisable with a high gain output valve.

The power supply is standard. With a 60 or 80 mill power transformer, the 5Y3, will provide almost exactly 250 volts between the plate and cathode of the 6M5.

CHASSIS

The receiver is built on the same chassis as was used for the 1951 Advance. Not only does the general layout suit the job quite well, but by so doing we avoid having a new chassis design. Its suitability is due largely to the fact that the tuning end is almost the same as for the earlier set, which also employed the wide-range circuit. Changes to the actual hook-up aren't of a nature which would change the layout in general.

We will have to modify the valve socket holes on the blueprint to allow for Noval sockets to be used throughout, but if your chassis is is an original, a few minutes work

Goldring

. . . IS DEFINITELY THE BEST VALUE IN 3 SPEED LONG PLAYING EQUIPMENT

(33 1-3, 45 & 78 R.P.M.)

NEW!

THIS POPULAR 3-SPEED RECORD PLAYER IS NOW AVAILABLE WITH TURNOVER CRYSTAL PICKUP!

See for yourself — and prove to yourself by comparing Goldring price and quality with other microgroove long-playing equipment. You will see that for quality reproduction for microgroove at 33 1/3 and 45 as well as standard 78 r.p.m. recordings Goldring just can't be bettered. You will find your microgroove and standard records take on new tonal qualities when played with a Goldring record player. And it's so simple to instal . . . you simply plug it in. Illustrated is the unit with B.S.R. Turnover Crystal pick-up. Also available with the GOLDRING high fidelity magnetic pick-up.

Price £25/4/6 retail
(Includes 33 1/3% Sales Tax.)

B.S.R. GU4 MOTOR and PICK-UP UNIT

BRITISH BSR THROUGHOUT

This superior unit is built by Birmingham Sound Reproducers Ltd., England, and leading radio manufacturers all over the world have selected it for its quality and performance. Little wonder that the GU4 Motor is preferred by record enthusiasts everywhere.

Price £15/15/- retail
(Includes 33 1/3% Sales Tax).

Available from your usual wholesaler or retailer.

There are two types of pick-ups . . .

- GU4/M High Fidelity Magnetic.
- GU4/C Turnover Crystal.

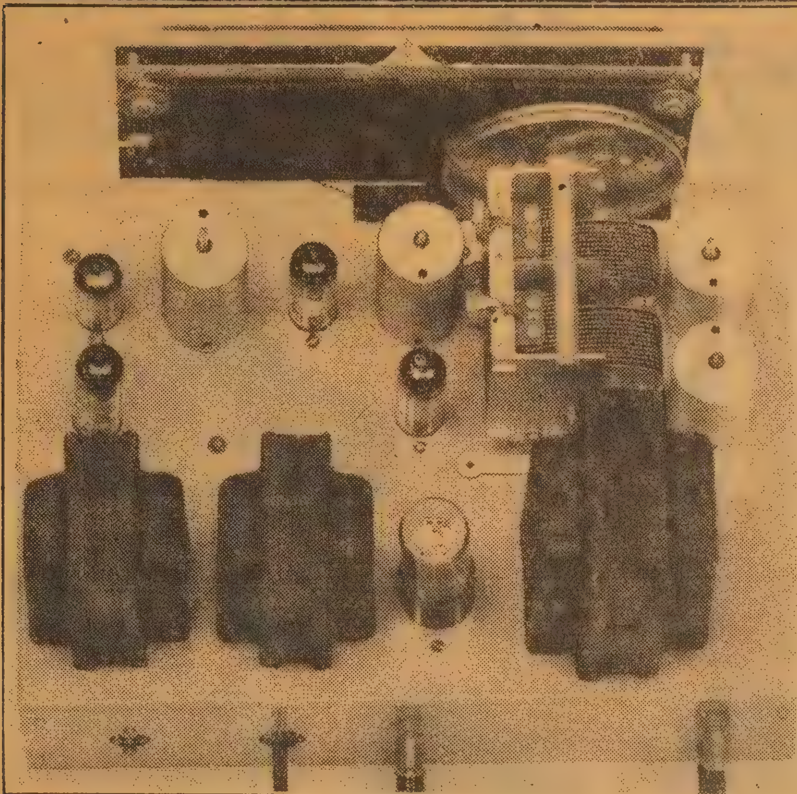
One side of the cartridge plays standard 78 . . . the other side plays Microgroove records simply by turning a knob.

GOLDRING ENGINEERING

(Aust.) Pty. Ltd.,
57 Area St., St. Mary's, N.S.W.

FULL TECHNICAL INFORMATION GLADLY MADE AVAILABLE

REAR VIEW OF ADVANCE CHASSIS



The set from the rear illustrates the well-spaced layout.

with a rat-tail file is all that is needed to enlarge two of the holes.

The rectifier socket will need enlarging, also, to accommodate an octal socket. It would be possible to retain the 6X4 rectifier, and even to forget the extra few volts which this valve will give as against the 5Y3. It might be wise, however, to wire a 300 ohm ·5-watt resistor between the cathode and the first filter condenser to drop the output voltage by the required amount. Then you can be sure that the maker's ratings won't be exceeded.

The inclusion of an output transformer on the chassis in addition to the power transformer and choke means that the holes punched in the chassis will no longer fit the case. Our photographs will show where these components are now placed.

It is doubtful whether it is worth while punching new holes for them, however, as the fitment calls for the drilling of only a few extra—four each for mounting, and one or two larger ones to accommodate the leads through the chassis. Because various makes of transformers and chokes are liable to require different hole positions, it is probably best to leave this to the constructor. Very few enthusiasts these days are without a hand drill and a few files. If they are, it's time they bought, or borrowed them!

PLACEMENT

It is definitely not advisable to use a transformer mounted on the speaker itself. Not only are such transformers not intended for wide-range results, but it is highly probable that oscillation will occur due to the over-long voice coil leads being incorporated with the voice-coil feedback system. One reason why this method didn't find great popularity some years ago was the danger of this very thing. Today, the position is different, as high-grade transformers are not hard to obtain. This is why we must re-arrange the chassis layout.

The power transformer moves over to the left-hand side (viewed from the front)and the output transformer is mounted on the right-hand side.

Our underchassis picture gives a good idea of where the components go. Their precise placement isn't critical, but there seems to be a fairly logical place for most of them, and no one should find it hard to avoid awkward connections.

OUTPUT TRANSFORMER

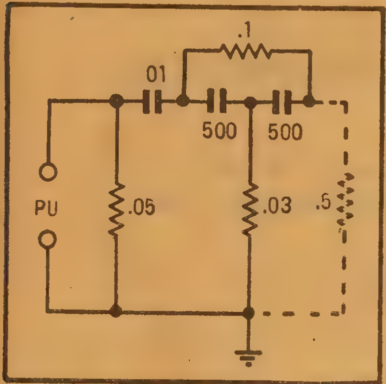
The terminal strip mounted on the chassis side obscures a few bits. At the bottom of the "pile" is the coupling condenser to the output grid, lying against the chassis. Above it comes the cathode resistor and bypass for the second half of the triode. These are anchored to a tie point on the strip, from which the 100 ohm resistor runs away to earth. The feedback resistor is mounted on the two unusual terminals of the output socket.

Mounted on the strip are one of the .25 meg plate resistors and the .1 decoupling resistor. The second .25 resistor runs vertically up to the strip, parallel with the 8 mfd decoupling condenser which can be seen.

The grid stopping resistor for the output valve is bridged across to a "no connection" terminal on the socket, the grid resistor being connected from that point to earth.

The bass boost condensers are hard to see because they are tucked away under the switch very close to the tuning flywheel. You may have to use two .02 condenser in parallel to get the .04 value as specified.

The wafer nearest the front of the chassis carries the switching for changing from radio to pick-up, and for cutting in the bass boost condensers. The other wafer of course switches the wide-range circuits and



Additional compensation pad for crystal lightweight pickup.

the treble boost condensers. It is worth while just working out the wiring to these points on the above lines before wiring in the components, and you will see that none of the leads are very long. Above all, don't get scared of that switch if you haven't used something of the kind before. There is nothing hard or critical about it.

SHIELDING

As the amplifier section of the set hasn't very high sensitivity, there is no need to shield the leads to and from the volume control. These leads are well away from the filaments, and don't pick up any hum worth worrying about. The leads to the pick-up, however, should be shielded, and the braid earthed preferably at the valve socket only. It is possible to introduce slight eddy current hum into the pick-up circuit, otherwise, although you'll see that the power transformer is mounted at the other end of the chassis to avoid such effects. It's just a point to remembber if you do get hum at this spot.

For convenience, the .05 pick-up load resistor is mounted across the pick-up terminals.

A tone control makes up the fourth knob, and is included more as a make-weight than anything else. It is sometimes helpful, however, and operates on both radio and records.

When mounting the coils and valve sockets, there will be one position for each which gives the shortest plate and grid leads. Watch this before you start wiring. Twist the filament leads tightly together and put them in first. Then wire in the coils.

Make the bridge connections between the appropriate switch points before mounting the switch in place. Connections to the bass boost condensers might be a little awkward due to their position under the switch, and it might be good to leave the dial off until these are in place. You can get your soldering iron to the switch through the dial cut-out.

As an indication of how easy the set is to get going, we started wiring one Saturday evening, and had the amplifier operating on records before going to bed. By the next evening, working at odd times during the day, the radio section was wired up, and (after inserting a screen feed resistor we had forgotten) the set worked right away.

Lining up is quite easy. We checked the 1F channel on an oscillator, but most 1F's these days come lined to frequency. In your case it will probably be a matter of tuning in a strong station, and, roughly, adjusting the trimmers to get good volume.

ALIGNMENT

Tuning to 2SM or a station thereabouts, the trimmers are adjusted until the station corresponds with the dial marking. Moving up to 2FC or its equivalent, the oscillator iron core is adjusted until it also checks with the dial. A second check on 2SM using the trimmers again will, correct any movement, and a last check on the oscillator iron core at the top end of the band will make sure that 2FC hasn't shifted as a result of the 2SM check.

Finally, adjust the aerial iron core on 2FC for maximum volume.

In other words, the trimmers only are used at the high frequency end of the dial, and the iron cores at the low frequency end.

A final check for exact adjustment can often be made best by tuning off the stations, and using the noise level as an indication. This will be highest when the circuits are correctly lined up.

A final adjustment of the 1F iron cores will complete the job. Don't touch the IF's until you have lined up the tuner, or you may be in real strife. And, in any case, make a note of how many turns either way you move the 1F cores in case you wanted to go back to the original adjustment.

If you are lucky enough to borrow an oscillator for lining up, so much the better. Our coils were taken from stock, and the set lined up perfectly, with all stations right on the dot.

My own view of this set is that it is the nicest five-valve radiogram by far that I have ever built. For general purpose work it is better than anything I know of at the moment, and even for high grade listening, is only bettered by my recording outfit which uses a TRF tuner and 10 kc whistle filter. This job, however, is for local work only, and hasn't the punch of the Advance 1952 as a station-getter. When used in the normal radio position, there isn't much you are likely to miss!

CIGARETTE LIGHTER

WHEN your cigarette lighter begins to misfire and at best sparks only weakly, it's likely that the wheel needs cleaning. To do this, scrape the accumulated grit and dirt from the grooves of the wheel with the point of a pin or needle and then brush vigorously with an old toothbrush. In time, the follower spring which maintains pressure on the flint becomes weakened by corrosion and rust and should be replaced.

Action of the follower spring often can be improved, at least temporarily, by fitting the head of a pin into the forward end of the spring. Cut the body of the pin about ¼in. below the head and insert in the open end of the spring. This will increase the pressure on the flint.

If you have decided to build the "PLAYMASTER BABY" AMPLIFIER which is featured in the December issue, the following Ferguson Transformers suit the requirements of the circuit.

POWER TRANSFORMER, TYPE PF151A

Primary Volts 200, 230, 240.
Secondary Ratings 285V aside at 60 mA. 6.3V at 2A, and 5V at 2A.
This Transformer is upright mounting, finished in a pleasing black brocade.

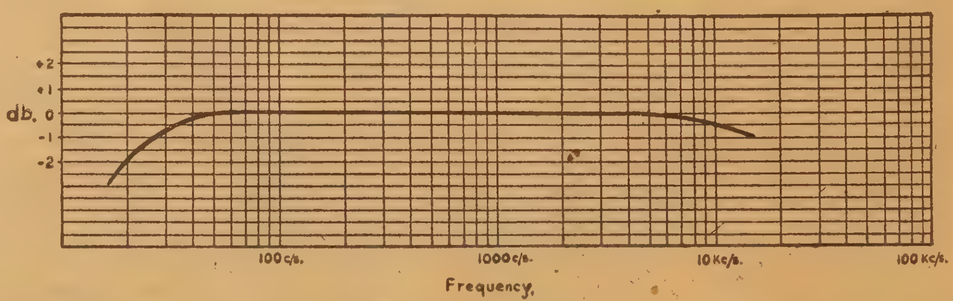
FILTER CHOKE, TYPE CF103

Inductance, 30 henries at 60 mA DC.
This Choke is designed for the power Transformer above.

OUTPUT TRANSFORMER, TYPE OP24/15

Primary Impedance 5000 ohms S.E. Max. Power 6 watts.
Secondary Impedance 15 ohms.
A feedback winding is incorporated for use if required.
The frequency response is flat within 1 decibel in the range 20 to 15,000 cycles per second. The response curve for this Transformer is shown below.

FREQUENCY RESPONSE - OUTPUT TRANSFORMER TYPE OP-24/15.



Also in the December issue is the "JUBILEE PORTABLE," suitable for Battery or AC operation for which the following Ferguson Types are suitable.

POWER TRANSFORMER TYPE PF201

Primary Volts 240
Secondary Ratings 225V aside at 50 mA, 6.3V at 2A, and 5V at 2A.

FILTER CHOKE TYPE CF102. Inductance 15 henries at 60 mA DC.

FERGUSON TRANSFORMERS PTD. LTD.

Ferguson Lane, Chatswood. Phone JA2878.

SOME FURTHER TESTS ON PICKUPS

We have had the opportunity during the month of testing several current-model pickups and our findings are published for the guidance of readers who may already have purchased them.

IT must be stressed that the curves are for individual samples only, as time did not permit us to run lengthy tests and strike average values for all three.

The first unit tested was the "Chancery" crystal pickup, which is being recommended as a unit suitable for direct connection to an existing receiver or amplifier. The crystal element ensures adequate output from both 78 and LP discs, while the naturally rising bass response compensates substantially for recording characteristics.

We accordingly tested the Chancery pickup on this basis, feeding it directly into a 0.5 meg. volume control, without additional compensation.

The response curve of figure 1 shows the ACTUAL OUTPUT from a 78 and a microgroove test record, both incorporating the usual British turnover characteristics.

USEFUL CURVE

The curve of 78 rpm does not deviate from reference more than 3db to 6 Kc, being approximately 5db down from there to its virtual cut-off at about 11 Kc.

On microgroove, the curve follows the same general shape, but is elevated above the reference line by the pre-emphasis on the record. In the normal receiver or amplifier this could be countered by turning down the tone control.

For more accurate compensation, the same type of circuit could be used as suggested for the "Acos" GP-20 crystal pickup, on page 50 of the November, 1951, issue.

The needle suspension employed in the Chancery pickup is actually very similar to the GP-20, the main point of difference being that the stylus lever can be withdrawn for replacement. The slight additional mass involved probably accounts for the lowering of the main treble resonance by about 1 Kc.

Output at 1000 cps was 0.3 V. RMS for microgroove and 0.7V for 78—this into a 0.5 meg. load. Peak output on loud music passages would therefore approach 2.0 volts in both cases, being emple to drive any ordinary receiver and amplifier. Waveform throughout the range was excellent.

We also had an opportunity of testing one of the new Decca magnetic pickups, as used in many imported Decca record players and radiograms.

These pickups have interchangeable plug-in heads, with three active connections. In Decca equipment, the output from the head is fed directly to an R/C pad, which is automatically modified as the 78 or microgroove head is plugged in. The pad reduces the available output drastically and calls for an amplifier having very high overall gain and level frequency response. The requirements are the same as for an ordinary microphone channel.

For the purpose of test, we disconnected the pad and fed the pickup directly into a .05 meg. load, being a usual value for this class of pickup. In the normal way, the signal would then be passed through a

(Continued on Page 103)

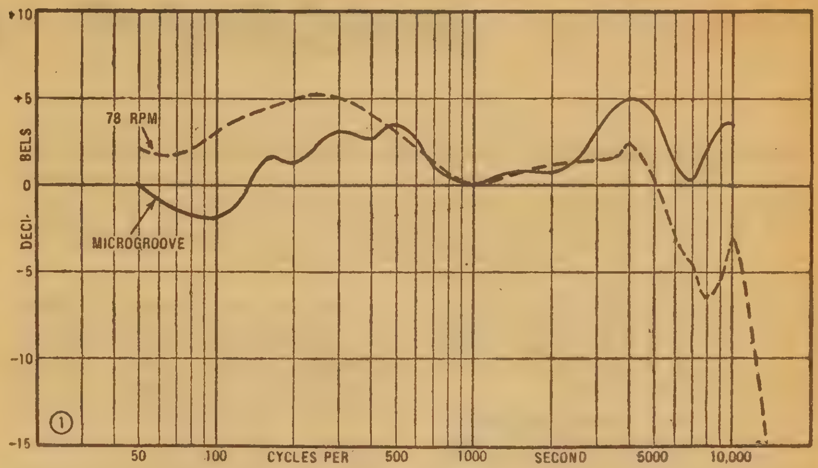


Figure 1. Actual output from the "Chancery" pickup into a 0.5 meg. load.

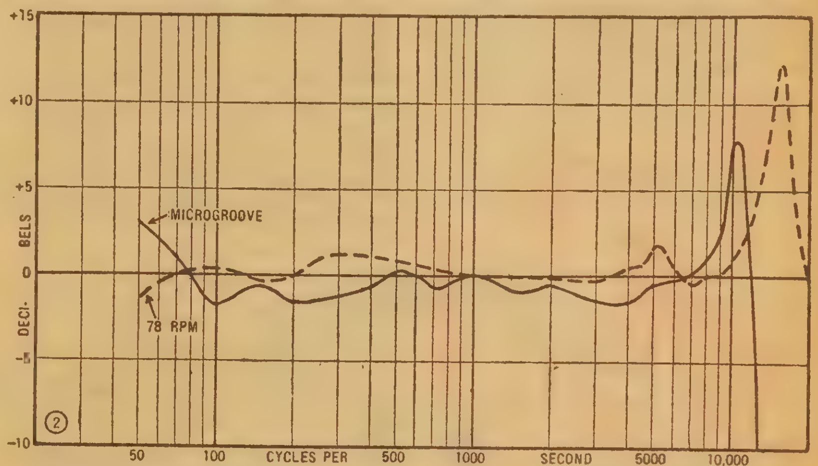


Figure 2. Output from the Decca magnetic pickup, as it would be after compensation.

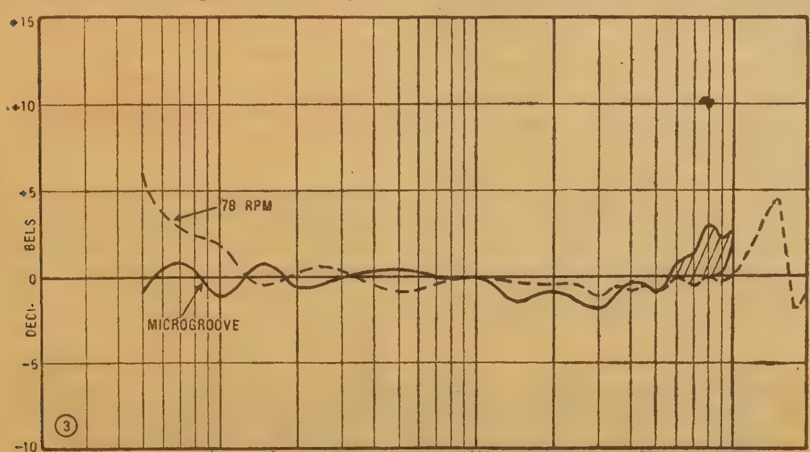


Figure 3. Output from the BSR magnetic pickup, as it would be after compensation.

Here's your answer, Tom!

Some of Tom's queries this month were actually sent in by readers with the idea of them being answered in the Answers to Correspondents section of the magazine. However, since they are of general interest we are taking the opportunity to answer them here in more detail than would be possible otherwise.

THE first query this month concerns tuning coils. We quite enjoyed answering it because it gives us an opportunity to discuss the history of tuning coils at length.

Why do many modern tuning coils have the windings enclosed in metal cups? Are they more selective than others?

In the early days of radio, tuning coils were massive affairs sometimes wound with thick copper tubing with numerous taps for adjustment. A knowledge of plumbing was a definite

advantage to the radio man of 25 years ago, especially if he had anything to do with transmitting.

After a time receiver coils got to be about 3in in diameter, wound with covered copper wire of about 18 or 20 gauge. These coils were very efficient indeed. In fact they were actually more efficent than many of the most efficient of modern coils. Why then, make a change?

TUNING COILS

Engineers had developed a means of using valves as radio frequency amplifiers which meant that more than one tuning coil was required in a receiver. Three coils were required if the receiver had two RF stages and, as you can easily imagine, Tom, three 3in diam. coils with appropriate shield cans take up a very large amount of space. Nowadays, we can build the whole set complete with power supply and speaker in less space than would have been required for the set of coils.

People were willing to put up with the large size for a time because of the vastly better performance of the multi-stage receivers. Each stage had a tuning dial and tuning in a station was more complicated than opening a combination safe. About the only advantage of the system was that it gave technical members of the family an opportunity to demonstrate their skill. The tuning of a station was not a matter to be undertaken lightly or inadvisedly.

Then, with one brilliant stroke, the operation of radio sets was brought within the ken of ordinary human beings. Somebody thought of the idea of connecting all the separate sections of the tuning condensers together and operating them from a single control. With the large coils the result was a huge contraption. Each coil had to be effectively isolated from its neighbor, both electrostatically and electromagnetically which would have meant large, costly shield cans and elaborate means of securing them in place.

So the coils were made smaller. For a time a diameter of about 1in was popular. The entire coil could then be fitted into a can about 3in diameter so that it was quite reasonable to mount a set of coils alongside a ganged condenser.

However, with their eyes on even more compact designs, engineers turned out even smaller coils. Most of them had a former about ½in diam. and a shield can about 1¼in diam. True, the new coils were not nearly as efficient as their predecessors but improvements in valve and circuit design made up for this.

LITZ WIRE

There was still room for improvement, however, and one of the first improvements was to substitute litz wire for the solid wire previously used. Litz wire is a wire made up of a number of fine conductors all insulated from one another by a layer of silk or enamel. The several strands are connected together only at either end of the coil.

This method of construction gave the coil a much greater efficiency than the old system. You see, Tom, radio frequency currents tend to travel on the surface of a conductor, with the result that the centre part of a thick conductor is largely wasted.

The litz wire made a big improvement because it has a much greater surface area for a given thickness of wire.

It was also found that for a particular coil it was possible to increase the inductance by placing an iron slug inside the coil. For a given inductance iron-cored coils have less resistance because the length of wire required is shorter and, therefore, the coils more efficient.

The inductance of the coil could be altered by varying the amount of iron inside the winding and this method, known as permeability tuning, is used for most coils nowadays.

IRON CORES

The metal cup you mention is simply an extension of the same idea. It increased the inductance of the coil for a given length of wire and at the same time tends to restrict the magnetic field of the coil with the advantage that it is possible to use a still smaller shield can if desired.

That is the answer to your particular question, Tom, but we would like to point out that the metal used has some very special properties. Actually it consists of thousands of tiny particles suspended in an insulating medium. If you hold one ohm meter terminal on a part of a good quality slug and then touch the other ohm meter terminal on to any other part of the slug, it will indicate an infinite resistance.

It's much too long a story to discuss at the moment but if a solid iron slug were used, the efficiency of the coil would be decreased rather than increased.

I have a small regenerative receiver in which I have used a large old fashioned tuning capacitor. At certain positions of the dial it is

possible to hear two or three stations at the same time and the stations are crowded towards one end. Do you think a standard capacitor would enable them to be separated?

The large tuning capacitor would account for the stations being close together on the dial and crowded towards one end but it would not cause them to be heard at the same time.

For example, a standard variable tuning capacitor has a range of from about 10 to 400pf. To cover this range it is necessary to turn the

shaft through an angle of 180 degrees. But if your capacitor has a range of, say 15 to 500pf it may only be necessary to turn the shaft through an angle of 140 degrees to cover approximately the same range, that is, from 15 to 400pf. In the latter case therefore, the stations will be closer together on the dial and crowded towards the low capacity end.

Take an extreme case, Tom, to illustrate the point more forcibly.

If you had a variable capacitor with a range of from 10 to 4000pf only 18 degrees of rotation would be necessary to cover the entire broadcast band. The stations would be very close together indeed and something special in the way of a dial mechanism would be needed to tune them properly.

The selectivity, or ability of the tuned circuit to separate adjacent stations, depends on its "Q" factor. (This is a convenient way of expressing the goodness of a tuned circuit.) In turn, the "Q" factor is determined mainly by efficiency of the coil, since the capacitor is normally very much more efficient than the coil.

SELECTIVITY

Therefore, the capacitance provided by the larger capacitor at any particular setting will have the same effect on the tuned circuit as the same value of capacitance provided by the other capacitor. At this particular setting the ability of the tuned circuit to differentiate between its resonant frequency and adjacent frequencies will be approximately the same.

To sum up the situation in practical terms, Tom, we would suggest that you buy a standard tuning capacitor, only if you find the tuning knob too critical or the fact that the stations are crowded towards one end of the dial is annoying. It would not make any difference to the set's ability to separate the stations. The only way to do this would be to add an RF stage or a pre-selector coil.

Just by the way, you may have noticed that many old-style tuning capacitors have semi-circular plates while the modern versions have specially-shaped plates which give a smaller change in capacitance for a given number of degrees rotation at the low capacitance end of the range. This spreads the stations more evenly over the dial. With the semi-circular plates the stations tend to crowd towards the high frequency end of the range.

CAR AERIAL

In the case of a car radio aerial, do the height and thickness of the aerial matter and does the speed of the car have any effect on reception?

From the general trend of your query, Tom, we gather that you are a little hazy about car aerials in general so in answering your specific queries we will take the opportunity to add some additional information.

First of all car radio aerials are generally a rather poor compromise between various conflicting requirements and good receiver performance is required to make up for their deficiencies. In order to be reasonably efficient by the usual standards a car aerial would need to be 20ft or 30ft long. Obviously, such an aerial would be quite impractical because you would not be able to travel under bridges and gateways without damaging the aerial.

Even an aerial 6ft long can come in for a lot of punishment. High speed, combined with vibration cause a great deal of strain and it is difficult to design an aerial capable of withstanding it continuously so the limiting factor is usually a mechanical one.

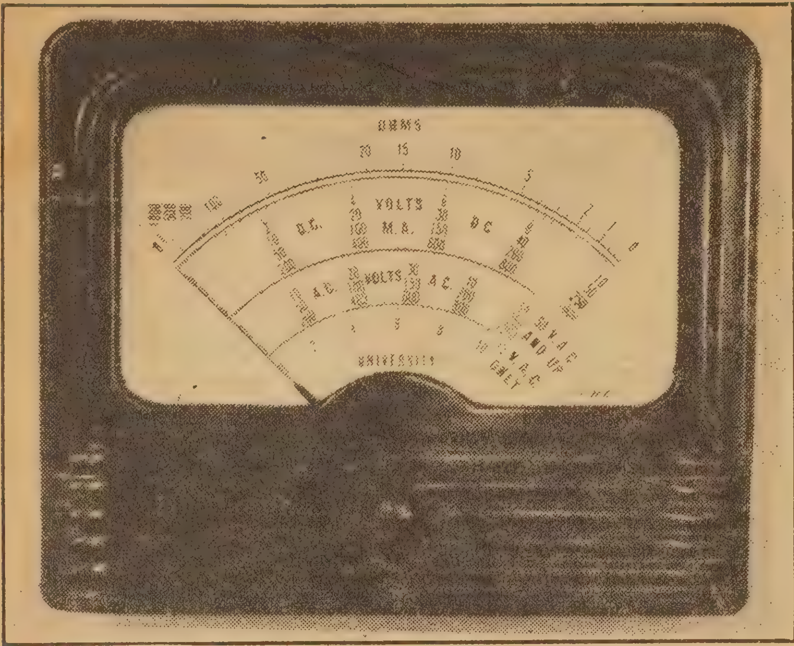
The average car aerial is made in sections and capable of extension to a maximum length of about 4ft 6in. With the sections collapsed it is shortened to about 18in. Given a modern receiver, there should be no difficulty in receiving all the local stations at good strength and with a good signal to noise ratio with the aerial almost right down.

If you wish to keep the aerial unkinked over a long period of time keep it as far down as is consistant with efficient reception. Out in the country you may need to use the full length of the aerial to overcome receiver noise, so that you have no choice but to replace the aerial more frequently.

The thickness of the aerial is of negligible importance electrically and in practice is determined entirely by mechanical considerations.

Since radio waves travel at 186,000 miles per second the speed of the car relative to the speed of the radio waves is negligible. There is no chance of the car outpacing the radio waves or anything of the sort.

Sometimes, on a dry day the whole car becomes charged with static electricity due to friction from the air. Periodically, the charge will succeed in leaking across the tyres resulting in a "click" in the receiver.



The heart of your multimeter is the meter itself and this is a typical example of the type at present available on the Australian market. Note the "OHMS" range which is at the top of the scale and which forms the basis of our present discussion.

At the same time as we tell you how to make each section, we will also describe how to use it, and give typical examples of the readings to be found when measuring various parts of an ordinary receiver. Thus equipped—with both the knowledge of how your instrument works and what are typical values to be read—you should feel a little more confident about tackling a fault when it does occur.

For this month we will discuss the general principles of this type of instrument, and explain, in detail, just how we arrive at that particular part of the circuit which is to be the first part of our project. Next month we will concentrate on the constructional side, or the putting of theory into practice.

WHAT WE WANT

To start at the beginning, just what can we expect of a typical multimeter? As already hinted there are three main characteristics which we need to know about an electrical circuit. These are (1) the voltage between any two points, (2) the current flowing past any one point, and (3) the resistance between any two points.

The last measurement is a very common one in one form or another. It is often called a continuity test and in many cases may be made with extremely simple equipment. The equivalent section in a radio multimeter is called an ohmmeter and it is this section which we have decided to describe first.

One of our main reasons for selecting it is that you are less likely to get into strife than if you started with the voltmeter or milliameter section. The ohmmeter can, in fact should, be used on a set which has no power applied. It cannot be damaged if the wrong range is selected, so you can fiddle around under a dead chassis to your heart's content, at the same time gathering much useful information.

LEARN WHILE YOU BUILD

By this time you should have successfully completed your first "Learn While You Build It" project. Like some more? OK then—here's our second project coming up! It is something a little different, but one which we feel will be every bit as interesting and successful as the last.

by Philip Watson

THERE comes a time in the life of every radio enthusiast (and we think you can be classed as such by now), when things don't work out exactly according to the book. A new piece of equipment fails to come up to expectations, the domestic receiver gives forth horrible noises or none at all, or a friend says, "You know something about radio" (proud moment), "my set's on the blink. Do you think, &c.," and so you are faced with the rather frightening problem of tracking down a faulty component (or something) with, let us be quite frank, not the vaguest idea where to begin.

CAN'T SEE IT

Now it's a funny thing about electricity, you can't see the stuff. You can feel it, of course—if there is enough of it—but this method is unpleasant at the best, while at the worst it can be downright dangerous, and is quite definitely not recommended. But the fact remains that if we are going to find out what's wrong with a set we will have to know just how much current is flowing in a particular wire, what voltage is between point A and point B, or how much resistance there is in such and such a component.

All of which is simply leading up to the idea of a meter, or a multimeter to be exact, which is about the most useful single piece of test gear you can get, and by far the best value for a limited outlay. That is not to say that it will do all the testing of a faulty receiver far from it but it will enable you, with a little experience, to track down the great majority of ordinary faults.

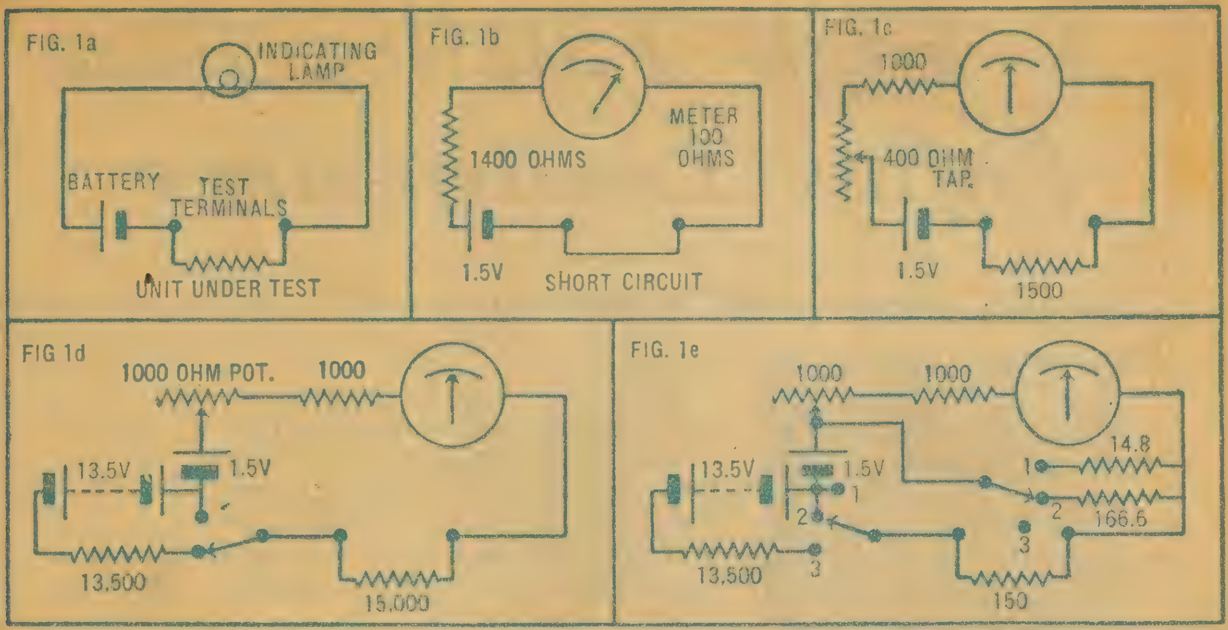
With this idea in mind we have decided to describe a multimeter which you can make yourself and, in so doing, learn something of what makes the thing tick. By spreading the construction over a number of issues we will be able to explain each section separately, something which is extremely difficult when a beginner is faced with a complete circuit diagram of the whole works.

Also, by taking things a little at a time, we have no qualms about describing a test unit which is just about as versatile as one could wish, whereas if the job had to be done in one bite we would feel inclined to describe something of a much simpler nature.

SIMPLE TESTER

An example of a very simple continuity tester is shown in figure 1a, where the battery is used to force a flow of current through the unit or circuit under test, while the lamp is used to indicate when the current is flowing.

Now such a device, while it may be perfectly satisfactory in some circumstances, has very definite limitations. For one thing there would be many occasions on which there would be a flow of current through the unit under test but no indication in the lamp. This is simply because the amount of current flow would be below the figure required to heat the lamp filament, or in other



This group of circuits shows how the ohmeter has evolved from the simple continuity tester to the versatile multi-range instrument which is regarded as standard for modern test equipment.

words our indicating device is not sensitive enough.

Another limitation is that, even when it does indicate a current flow, there is no means of knowing just how much is flowing. If we know how much is normally needed to light the lamp we may be able to make a rough estimate from the brilliance of the glow, but at the best it would be a very rough guess. In any case we are not so much interested in the actual current flow as we are in resistance which is permitting it, and can only find this by resorting to calculation, a procedure we want to avoid if possible.

DIRECT READING

In other words we require an indicator which is not only sufficiently sensitive but which will indicate exact values in the correct units. This brings us to the heart of our multimeter—the meter itself

Fundamentally this is a current measuring instrument but, by means of associated circuitry, it is possible not only to extend its range as a current meter but also to make it function as a voltmeter and an ohmmeter.

This multiple use of the one meter for a number of functions is both convenient and economical, for it would clearly be both costly and bulky to have to provide a separate meter for each. Theoretically there is no limit to the number of ranges which may be built around one meter, but if this idea is carried too far the result is likely to be an electronic "Frankenstein monster" which takes a lot of handling. Long experience has indicated what is the best compromise between cost, complexity, and versatility.

One factor which limits the number of ranges is the availability of suitable switches, the maximum number of positions normally available being 12. To keep an instrument reasonably simple it is not desirable to have more than one control for the main selector, which automatically limits us to a maximum of 12 ranges. However, there is no objection to using a separate switch for such functions as AC/DC switching and this effectively increases the number of ranges without greatly sacrificing ease of handling.

There are a number of ways in which a flow of current may be made to operate an indicating pointer, but one of the most popular methods is to use the magnetic field which a flow of current causes. Those of you who have been following the current series on the fundamentals of electricity will know that you can produce some very violent reactions by placing a wire, carrying current, close to a magnetised needle.

In figure 2 we have a diagrammatic representation of the popular "moving coil" meter and it is as well to get an idea of the operation of this before discussing the circuit to be built around it.

The essential principle is that of a coil of wire suspended in a magnetic field. The magnetic field is provided by the permanent magnet and by means of the semi-circular pole pieces and the central iron core. The field is concentrated into the narrow circular gay between the two.

MOVING COIL

The coil is wound on a rectangular aluminium former and is suspended so that the two sides of it are free to rotate in this magnetic gap. To the centre of the top and bottom of the coil is fastened a precision ground pivot which rests in a jewelled bearing similar to that used in a watch.

Also attached to the coil at this point is a fine hair spring, again similar to a watch (but of non-magnetic material), the other end of which is anchored to the frame of the meter. The main purpose of these two springs is to provide a standard force against which the rotational force of the coil can be compared, and also to restore the movement to the zero position when current ceases to flow. A secondary job is that of providing a flexible connection between fixed contact points on the frame of the meter and the moving coil.

In addition to these major parts, there are such refinements as the counterweight to balance the weight of the pointer and a means to exactly zero the pointer, which may vary its position slightly with temperature and mounting angle. This latter adjustment is usually brought out to the front of the meter in the form of a screwdriver slot for greater convenience.

MAGNETIC FIELDS

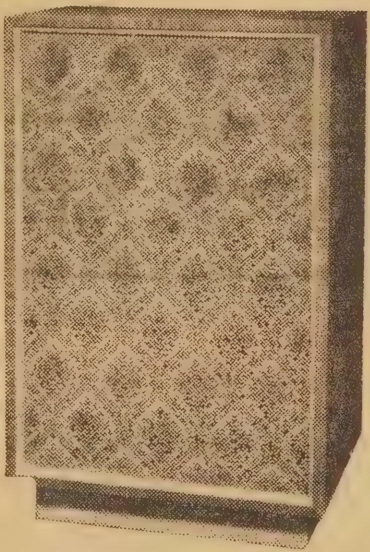
When current is caused to flow through the coil (by the application of voltage to it), the magnetic field which is formed reacts with the field of the permanent magnet in such a way as to cause the coil to rotate on its bearings, thus moving the pointer across the scale. The amount by which the coil rotates depends on such factors as the number of turns, the strength of the permanent magnet, the strength of the springs, and the amount of current flowing.

When the first three factors are standardised it becomes possible to calibrate the scale according to the fourth, the current flow, and thus we have a current-measuring instrument. A feature of the moving coil meter is that its response is linear, which is just another way of saying that equal increases in current flow will cause equal increases in the pointer movement. This is in contrast to some other types which have non-linear responses, and, as a result, use scales which are crowded at one end or the other.

It is possible to make an extremely sensitive instrument using the moving coil principle, and, by the use of high-grade materials, particularly the pivots and jewels, a full-scale deflection sensitivity of the order of 20 microamps can be obtained. (One microamp is 1-millionth of an amp.)

A High Fidelity Bass Reflex Loudspeaker

MODEL VE50 PRICE £45/17/3



This unit comprises a selected Goodmans Axiom 150 loudspeaker mounted in a bass reflex cabinet (vented enclosure). Each unit is individually adjusted for resonance. The cabinet is supplied unpolished for matching your existing furniture.

Only supplied complete with loudspeaker and connecting plugs ready for use.

Dimensions: Height 39", Width 25", Depth 17½".

MODEL VE7 PRICE £22/12/9

Similar to Model VE50, only less loudspeaker. This unit is a bass reflex cabinet designed for 12" loudspeakers having a fundamental free air cone resonance between 50 and 60 cycles.

Unpolished cabinet only

Dimensions: Height 35", Width 22½", Depth 16½".

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Since the scale can easily accommodate more than 20 divisions, such an instrument would have no difficulty in indicating a flow of one microamp.

Incidentally, the figure quoted above should not necessarily be regarded as the absolute sensitivity achieved. It is quite possible, particularly in special cases, that more sensitive instruments have been made, but this will give you some idea of the region of maximum sensitivity. Naturally the amount of energy provided by such a flow of current is extremely small and an instrument with such a sensitivity has to be very carefully made, the bearings especially requiring to be as nearly a perfect surface as human skill can make them.

This means an instrument which is both delicate and expensive, and rather out of the class required for everyday radio servicing. A range more in keeping with reasonable cost, reliability, and sensitivity is one milliamp for full-scale deflection. (One milliamp is one-thousandth part of an amp, or 1000 microamps.) It is around such an instrument as this that we are designing our present multimeter.

The internal resistance of a meter is a very important factor which must be known in order to calculate the resistance of such auxiliary items as shunts and low voltage multipliers. At one time this was a rather variable factor, different brands, particularly imported types, having different values of internal resistance. To make things still more difficult the values quoted for any particular brand were only approximate and for really accurate results it was necessary to wind shunts for each meter individually, a job which was beyond the technical facilities of most beginners.

STANDARD RESISTANCE

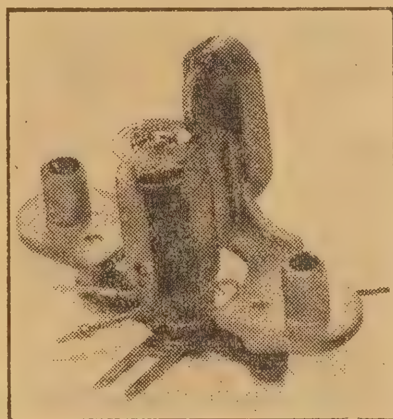
Fortunately most Australian manufacturers have standardised on an internal resistance of 100 ohms, part of which is made up by the coil itself and part by the inclusion of a small resistor. By adjusting the value of this latter item it is possible to compensate for small variations in the coil resistance and thus produce all meters with a standard resistance.

Having standardised the meter resistance it then becomes possible to produce shunts, &c., on a commercial scale which will work quite satisfactorily without the need for individual matching, thus eliminating one of the major problems of the home constructor.

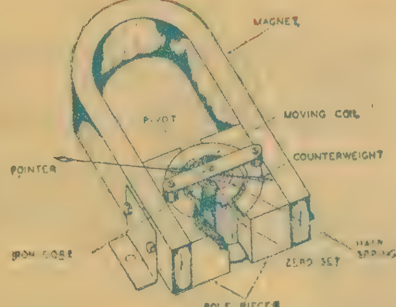
So much then for the meter itself. Now to incorporate it in our ohmmeter circuit. We could simply substitute it for the lamp in figure 1a and there is no doubt that such an arrangement would be extremely sensitive. As a matter of fact it would be far too sensitive and a low value of resistance in the circuit under test would pass much more than 1mA through the meter, possibly causing serious damage.

To prevent this possibility it is necessary to limit the current through the meter so that even under short circuit conditions it cannot exceed. 1mA. Assuming a 1.5 volt battery we can calculate (by Ohm's law) that the total resistance in the circuit will need to be 1500 ohms in order to create this condition. In figure 1b we show how this resistance is distributed, 1400 ohms being provided by an external resistor and 100 ohms by the meter itself. When the test terminals are short circuited (zero ohms) the meter will now read exactly full scale and we may calibrate this point as zero on our ohms scale.

Since we cannot depend on the battery voltage being exactly 1.5 we must make provision to compensate for variations over a small range. This is done by making part of the series resistance variable, and the values are so selected that it is not



A photograph of the "works" of a moving coil meter. This shows all the essential parts, except the magnet, such as the central core, the coil, the hair springs, etc. The pivots and jewelled bearings in this case are mounted inside the coil former.



A diagram showing the assential parts of a typical moving coil meter. This should be studied in conjuncton wth the text where the function of the individual parts is discussed.

possible to compensate for more than a reasonable variation. Thus a battery which is due for replacement will be indicated by a failure of the pointer to come to zero. A typical set-up is shown in figure 1c.

In this circuit, we have also shown a 1500 ohm resistor between the test terminals, and it is interesting to analyse the effect this will have on the reading of the meter. The total resistance in the circuit is now 3000 ohms, just twice what it was under short-circuit conditions, and it can be calculated that the amount of current flow will be halved. Thus, with only .5 mA flowing, the meter will read half-scale and we can calibrate this point as indicating 1500 ohms.

A further calibration point is provided by leaving the test terminals open circuit, when it will be found, quite naturally, that there is no deflection of the meter at all. This point may be therefore calibrated as "infinity." It would be possible, by similar calculations, to calibrate all the required points on the scale, but it would be a tedious job, and, fortunately, is quite unnecessary, because the meter scale is already calibrated on this basis. The fact that the figure in the centre is 15 and not 1500 will be explained in a moment, but it does indicate that the scale should be used with a 1.5 volt battery.

The circuit as it stands (figure 1c) is a true ohmmeter circuit and within the limits of a single range will give perfectly satsfactory readings. However, resistance values below about 25 ohms or above 100,000 ohms will give readings so close to the respective ends of the scale that accurate measurements are impossible. The next step, then, is to extend the range of the instrument both above and below that of the fundamental circuit we have just evolved.

First let us consider an increase in sensitivity which will allow higher values of resistance to be read. This is comparatively easy, it only being necessary to multiply the battery voltage and the total series resistance by whatever factor we wish to increase the sensitivity. Ten is a very convenient factor by which to separate our ranges, since it makes possible the use of one scale for all, it only being necessary to add or subtract noughts as required.

HIGHER RANGE

To increase the range by 10 we will, therefore, require a battery voltage of 15 and a total resistance of 15,000 ohms. Figure 1d shows how this is added to the original circuit. As you can see, it is simply a matter of adding a 13.5 volt battery and a 13,500 ohm resistor in such a way that it can be switched into circuit when required, the existing 1.5 volt battery and 1500 ohms of resistance bringing the total up to the required value. The whole of the scale has now been multiplied by 10, so that the highest reading will be 1-million ohms or 1 megohm, and the lowest 250 ohms.

The extra battery is conveniently made up from three 4.5 volt flat torch batteries, such as the Eveready type 703, and, as the current drain is still only one milliamp, the life of these batteries is usually determined by their shelf life. It would be possible to extend the range even further, but, as the next multiple of 10 would call for 150 volts, it is not very convenient or economical to use batteries. However, such a range is sometimes used in power-operated testers such as combined multimeters and valve testers, where a small power-pack can supply the necessary voltage.

Equally as important as the ability to read high values is the ability to read very low values, so our next job is to decrease the sensitivity. One way to do this might be to use a .15 volt battery with a suitable reduction in circuit resistance — if such a battery was available. Since it isn't, we must adopt other measures, such as those shown in figure 1c.

Here a low value resistor (166.6 ohms in this case) is connected in parallel (i.e. in shunt) with the meter and its associated series resistor. The result of this is to reduce the total resistance of the circuit under short circuit conditions to one tenth of its previous value, or 150 ohms. The 1.5 volt battery now forces a current of

(Continued on Page 95)

A COURSE IN TELEVISION

Part 32—INTER-CARRIER SOUND RECEPTION

Efforts to simplify television receivers in the U.S. particularly have led ultimately to the development of the "inter-carrier" system of reception. The actual figures used in this paper are based on American practice but it is likely that the same principles will be used in Australian receivers.

IN recent years, a number of schemes (References 1, 2 and 3) have been disclosed for the simultaneous transmission of both picture and sound on a single carrier. In general, these systems were based on the use of a multiplex or time-division method of transmission, in which it was proposed that the audio modulation be impressed on the video carrier during the intervals normally reserved for the synchronisation pulses.

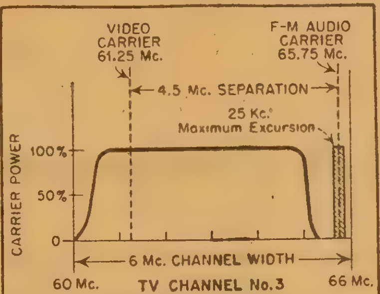
Because of the fact that these sync pulses occur only during the blanked portion of the kinescope trace, audio signals transmitted during the retrace or flyback period should cause no interference with the picture. However, since the ratio of sync pulse duration to video pulse duration is quite small, roughly 10 pc, the average audio power which can be transmitted during the sync pulse interval, with a given carrier is correspondingly reduced by a factor of 10.

SOUND LEVEL

This could be overcome to some degree by increasing either the sensitivity of the receiver or the transmitter power, but there are obvious objections to such measures.

Another point is that the adoption of any system of multiplex transmission would render obsolete accepted transmission standards and methods. In England and the US, it would be necessary to modify all transmitters and to modify or replace all existing receivers.

The "intercarrier" system, on the other hand, does not in any way alter the existing practice of transmitting separate picture and sound signals, apart from making it necessary for stations to control carefully their frequency, their depth of modulation



TELEVISION CHANNEL SPECTRUM ANALYSIS
FIG.1

Figure 1

and the general adjustment of the transmitter.

It remains essentially as a design principle in the receiver — a new method by which the FM sound and AM picture signals can be amplified simultaneously and then separated. Though opinions for and against are numerous, it appears that the inter-carrier principle is rapidly gaining favor in the US, which does employ AM for the picture-carrier and FM for sound.

In 1947, exposition was made in papers by Parker (Ref. 4) and Dome (Ref. 5) of the development of a new method for recovery of the audio intelligence contained in a composite television signal.

In this system, a 4.5 Mc. beat frequency, usually present as an undesired signal in the control grid circuit of the kinescope, is made to serve as what may be termed an audio sub-IF signal which can be amplified, clipped or limited and then demodulated in the usual manner.

It may be mentioned in passing that even though this ordinarily undesired signal is usually present in greater or lesser degree in all TV receivers, few manufacturers make particular provision for 4.5 trapping in the video amplifier circuit.

That such a 4.5 Mc. signal can exist may readily be seen from the following generalised consideration.

MIXER ACTION

It will be remembered that, in a conventional superheterodyne receiver, an incoming signal of frequency F and a locally generated oscillator signal on frequency f, are both passed through some non-linear device, variously termed the mixer, converter or first detector.

In the conversion process the two signals are combined and form an IF signal of frequency equal to the difference between F and f.

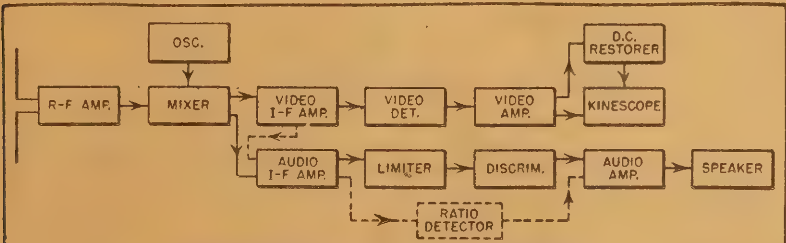
It must be stressed at this point, however, that this heterodyne or beat frequency will be generated only if the mixing device (vacuum tube, crystal diode, thermistor, &c.) possesses some non-linearity in its impedance characteristic.

In the conventional dual-IF television receiver, both the picture and sound carriers, comprising the composite television signal, are amplified by a common broad-band RF stage, heterodyned with a single local oscillator signal and converted to a complex signal containing video and audio IF components.

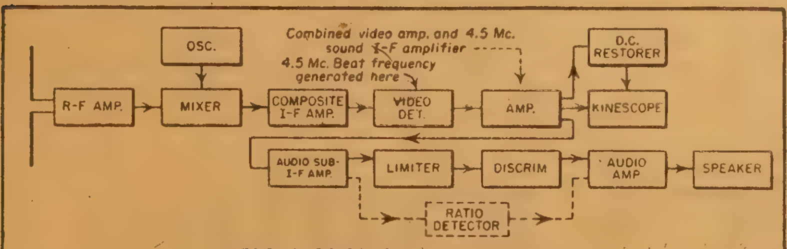
OSCILLATOR FREQUENCY

Although the conversion process lowers the frequency of the two carriers, the 4.5 Mc. frequency difference between them remains unaltered.

If, as is usually the case, the oscillator is operated on the high frequency side of the signal, a sideband reversal takes place, i.e., the relative



CONVENTIONAL DUAL-I-F TV RECEIVER
FIG. 2



INTER-CARRIER SOUND TV RECEIVER
FIG. 3

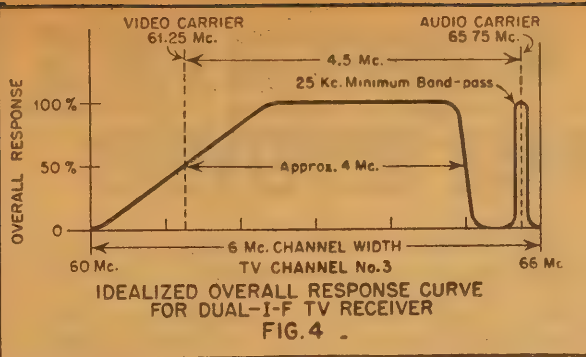


Figure 4

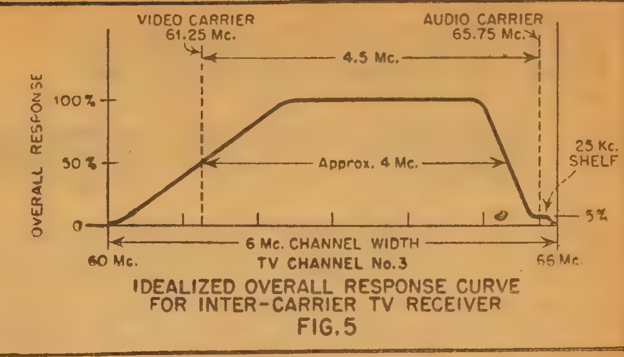


Figure 5

positions of the video and audio carriers are interchanged.

The use of a common RF amplifier, mixer and oscillator for both picture and sound adds to the ease of operation and at the same time affords a material saving in cost.

A natural extension of this dual function technique to the IF portion of the receiver has resulted in the recent appearance on the market of several commercially designed TV receivers in which one, or even two, of the IF stages are made to function as combined picture and sound amplifiers.

From this point on the signals are separated by appropriate filters or traps, amplified further as required and then demodulated as shown in Fig. 2.

In the intercarrier sound system, Fig. 3, both the picture and sound IF signals are handled simultaneously by a common wide band multistage IF amplifier.

In the video detector, usually a vacuum tube or germanium crystal diode, the frequency modulated sound IF signal is heterodyned with the amplitude modulated video IF signal. The resulting 4.5Mc beat, produced by the non-linearity of the detector characteristic, is both frequency modulated by the sound and amplitude modulated by the video.

BOTH FM AND AM

It has been shown, however, that if a low level FM signal is heterodyned with a high level AM signal the resultant signal is largely frequency modulated and is relatively free of AM.

This 4.5Mc sub-IF is further amplified by the video amplifier, passed through one or more amplifier limiter stages where the residual AM is removed and is finally demodulated by any of the well-known methods of FM detection. Use of the ratio detector for this function can actually provide adequate AM clipping without resort to a separate limiter.

Although not adequately demonstrated by the simple block-diagrams of Figs. 2 and 3, the intercarrier system represents a considerable simplification in circuitry when compared with the actual schematic of the dual-IF system of television reception.

STABILITY TROUBLES

In addition to this advantage, with its attendant economy, the Parker system possesses several other desirable characteristics, among which may be mentioned simplicity of tuning, freedom from oscillator drift and microphonism and reduction of inter-channel crosstalk.

The dual-IF television receiver suffers from the serious disadvantage that even comparatively slight mistuning or drift of the local oscillator seriously affects both audio quality and discriminator impulse-noise susceptability. In common with other types of FM reception, background noise and hiss are also increased by such oscillator maladjustment.

Automatic frequency control of the oscillator has been applied in certain television models as a means of reducing these shortcomings, but this, of course, adds to the complexity and consequently to the cost.

A commentary on the efficacy of AFC circuits as applied to TV receivers may be made by noting that one manufacturer, after marketing a receiver using AFC subsequently issued a modification kit for adding a fine-tuning control to sets in the field.

In the Parker system, the 4.5Mc frequency difference between carriers, which serves as the sound IF, is maintained by accurate control at the transmitter, rather than by the relationship existing between received and locally generated signals. It is immune, therefore, to the above-mentioned troubles.

Since the video IF is normally of the wide band type, misadjustment or drift of the local oscillator, sufficient to cause severe distortion of the sound in dual-IF receivers, causes no appreciable degradation of either picture or sound quality in sets equipped for intercarrier sound reception.

The discussion thus far of the comparison between the two systems has been confined to the credit side of the inter-carrier ledger. There are, of course, the ever present debits.

Chief among these is the susceptibility of the inter-carrier system to audio interference caused by; (a) frequency or phase modulation of the video carrier (b) momentary disappearance of the video carrier during modulation peaks (c) failure at the transmitter to maintain accurately the prescribed 4.5 mc difference between video and audio carriers, and (d) drift of the receiver discriminator tuned circuits.

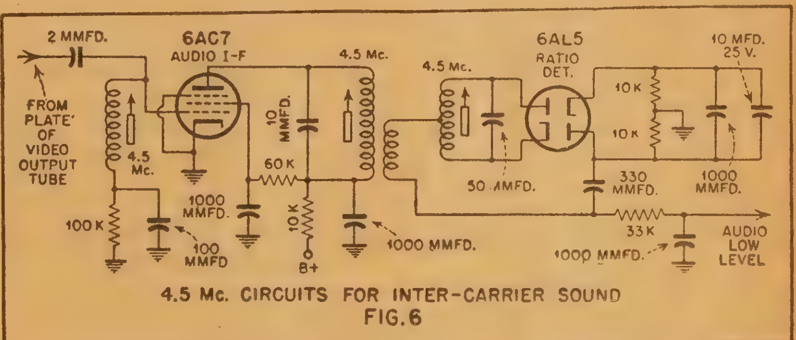


Figure 6

These conditions are further aggravated by the fact that the TV sound deviation is only 12.5Kc as compared with 37.5Kc for standard FM broadcast transmissions. The discriminator coil Q can, therefore, usually be made higher, requiring almost pin-point accuracy in TV set tuning.

60-cycle frequency modulation of the local oscillator in the standard dual-IF system, due to insufficient filtering or cathode heater leakage, is often manifested as objectionable hum in the speaker.

In one commercially built set it was found necessary to include a small dry-disc rectifier and filter to supply DC to the heater of the local oscillator to reduce such hum.

Acoustic feedback from the speaker diaphragm to any microphonic portion of the oscillator circuit, such as trimmers, condenser plates, switch contacts, coil slugs, tube elements, and the like, can cause annoying ringing or even audio howl at high volume.

The remedial measures necessary to reduce the above effects present no insurmountable problems, as may be seen from the following considerations:

(a) Frequency or phase modulation of the video carrier appears, in the Parker system, as undesired modulation and distortion products in the reproduced sound. This can be prevented, or at least minimised, by proper transmitter design and adjustment.

(Continued on Page 83)

DISPOSAL BARGAINS

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Huge Purchase, 300 Brand New in Original Cases

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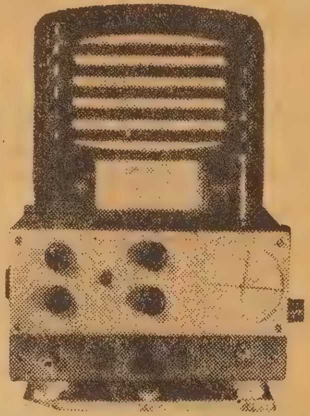

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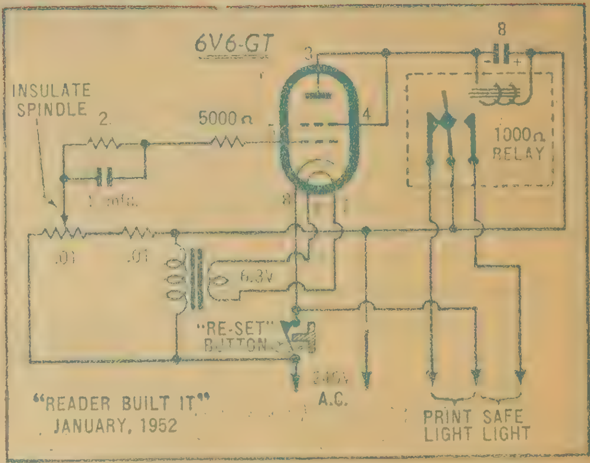
A READER BUILT IT!

Gadgets and circuits which we have not actually tried out, but published for the general interest of beginners and experimenters.

ELECTRONIC TIMERS AID PHOTOGRAPHIC PRINTING

Whether it's for the practical benefit or just for the fun of it quite a few readers like to introduce electronics into their hobby of photography. This month we display the efforts of two contributors in the form of designs of electronic timers for printing.



The print lamp will, of course, be external to the timer unit. It may be necessary to adjust the sensitivity of the relay. Switch S1 may be a wafer, push-button or toggle type.

DEALING first with the design of L. A. C. Day, RAAF, Ballarat, Victoria, we see that it features portability and battery protection.

Briefly, the operation of the circuitry is as follows: With S1a, S1b closed and S1c open, the 22.5 volt battery charges the 5 mfd capacitor, and, because the grid is connected to the filament, the valve draws current. The relay in the plate circuit closes its pairs of contacts Ra and Rb.

When the combination switch is released, S1c closes the light circuit and the relay contacts Rb maintain the battery supply to the valve, while the charge on the capacitor leaks away at a rate depending upon the amount of resistance connected across it.

TIMING OPERATION

From the commencement of the timing operation, the plate current will begin to fall. At a certain level of plate current, depending upon the sensitivity of the relay, the contacts Ra and Rb will open, switching off the printing light and the A and B supply to the valve.

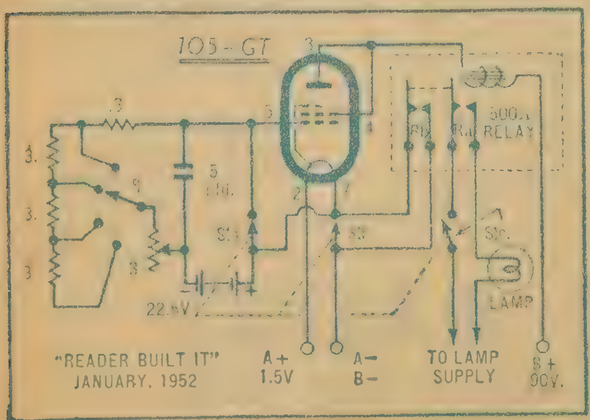
All other factors remaining constant, the amount of resistance across the capacitor governs the time of operation of the light. With the aid of switch S and the potentiometer, a wide variation of times can be obtained, ranging from approximately one second with only the .3meg. resistor in circuit. Shorter times of operation can be obtained with a lower value of resistance in this position, but other factors will then become critical, such as the quality of the capacitor and resistor and the condition of the batteries.

Points made by our contributor are as follows: The 5 mfd capacitor should be a good quality, oil-filled type. Resistors can be varied to suit individual requirements. The dial card for the potentiometer can be marked direct in "seconds" for each position of switch S. Combination switch S1a, S1b, S1c is a double-pole-double-throw marked "off" in the position where S1c would be closed. One bank is used for S1a and S1b, the other for S1c.

AC VERSION

The second circuit comes from Mr. L. Stocks, of 83 Blaxland St., Matraville, NSW.

When first switched on, the printing light will stay alight until the 6V6-GT reached operating temperature and the plate current closes the relay to the "safe" light.



☆

The relay is shown in the 'rest' position. The transformer is a standard filament type. The .01 megohm wirewound potentiometer should have the spindle insulated from the chassis and the operator. This same precaution should be taken with the 're-set' button.

☆

On pressing and releasing the "re-set" button, the 1 mfd capacitor charges from the mains and the grid current to a level depending upon the setting of the .01 meg. wirewound potentiometer. This will bias the grid, reduce plate current and the relay will "open" to bring the printing light into circuit. It will stay on until sufficient charge has leaked from the 1 mfd to allow plate current to close the relay. Our contributor says that with the values shown, the .01 meg. potentiometer in his unit gives a timing range of 1 to 9 seconds. For other time ranges, change the 1 mfd and the 2 meg.

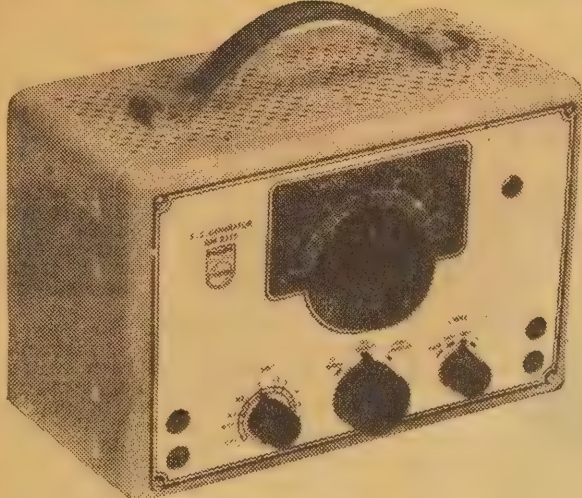
Possibly the most important point in the construction is to insulate the moving arm of the potentiometer from the chassis and to connect the shaft to the knob through a short length of insulated rod. This will remove any chance of getting a shock from these controls.

WARNING

We would like to warn readers again that one cannot be too careful in building and using units which have direct connection to the power mains, particularly those for use in a dark room. Completely enclose the unit in a water-tight case.

Our contributor remarks that by using a 15 ampere contactor across the terminals marked "printing lamp" and using a spot-welder's foot switch in lieu of the "re-set" button, he found the unit of great assistance in spot-welding activities.

TRADE REVIEWS AND RELEASES



The ger housed , a neat case, and altogether looks the high quality job it is.

PHILIPS NEW RC GENERATOR

As a companion to Philoscope II reviewed in last month's issue, Philips Electrical Industries have released an audio generator of neat appearance and excellent workmanship.

THIS generator, the working of which is based on the R-C principle, is entended for use in service workshops for the testing of l.f. amplifiers, the external modulation of h.f. oscillators with a frequency different from that of the internal modulation, &c.

The frequency range extends from 20 c/s to 20,000 c/s, divided into three parts. The three ranges can be changed over by means of a special disc adapter carrying different resistors for the R-C network.

For the frequency fine control there are two variable and mechanically coupled condensers, to the spindle of which the tuning knob is affixed (these condensers are identical). When the range knob is turned some of the switching elements (resistors) on the adapter are connected with fixed contact-springs.

The construction of the switch ensures a good contact and a high insulating resistance, thus contributing towards stable functioning of this generator.

The generated frequency is governed by the values of the condensers and resistors in the R-C network.

The output voltage is adjustable between the minimum voltage of 0.5 mV and about 10 V by means of a step attenuator and a continuous voltage - regulator with which the mains switch is coupled.

The plug sockets on the left are connected with the continuous voltage regulator and those on the right with the step attenuator.

The apparatus is provided with a fixed mains flex. A signal lamp indicates whether the apparatus is switched on.

Frequency range:

20—20,000 c/s divided as follows:
20— 200 c/s
200— 2000 "
200—20,000 "

Frequency accuracy:

After the apparatus has reached its working temperature the frequency tolerance is less than 5 pc, whilst the reading error is less than 2 pc.

NICHOLS SOUNDCRAFT RECORDER

Nichols Soundcraft Co. has announced a new broadcast type tape recorder intended for use where high quality sound is an essential plus complete editing facilities.

THE recorder, known as Model 10, weighs 60lbs in a leatherette case and is built with rack and panel construction. The portable model uses 8¾in panels and the rack mounting version 10½in panels.

The recorder is of the three head type and is fitted with three motors. Either 7½ or 15in speeds are available for recording determined by the capstan and pinch wheel assembly. Equalisation for each tape speed is selected by a panel switch.

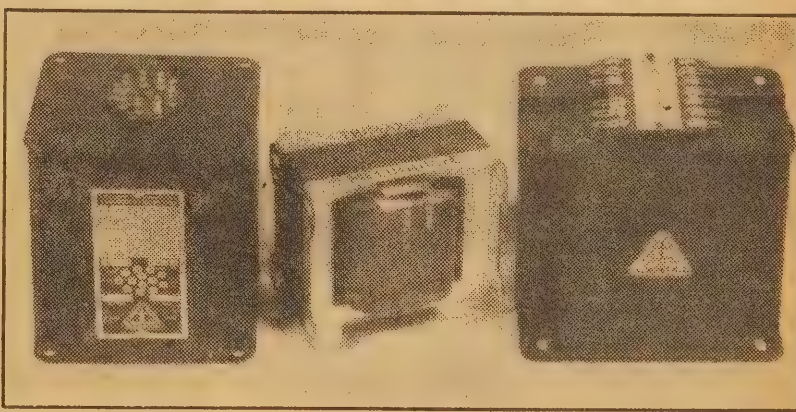
The use of three motors allows fast speeds either forward or reverse, the tape being easily unlaced from the heads for the purpose.

Provision is made for inputs of 50 ohms, 600 ohms balanced line, and one high impedance bridging circuit. Outputs are to 2, 8, or 600 ohm line. A separate volume control is available for a built-in monitor speaker.

Operation of transport mechanism is by a three position switch—Forward, Stop, and Rewind.

The unit is attractive in appearance and performs well.

TRIMAX PLAYMASTER TRANSFORMERS



MESSRS. Cliff and Bunting, makers of Trimax transformers, have sent us a kit suitable for use in the Playmaster amplifier, consisting of a power transformer, filter choke, and output transformer.

The name of Trimax is sufficient guarantee of quality and workmanship. The illustration shows that these samples of the wide Trimax range are well up to their high standard.

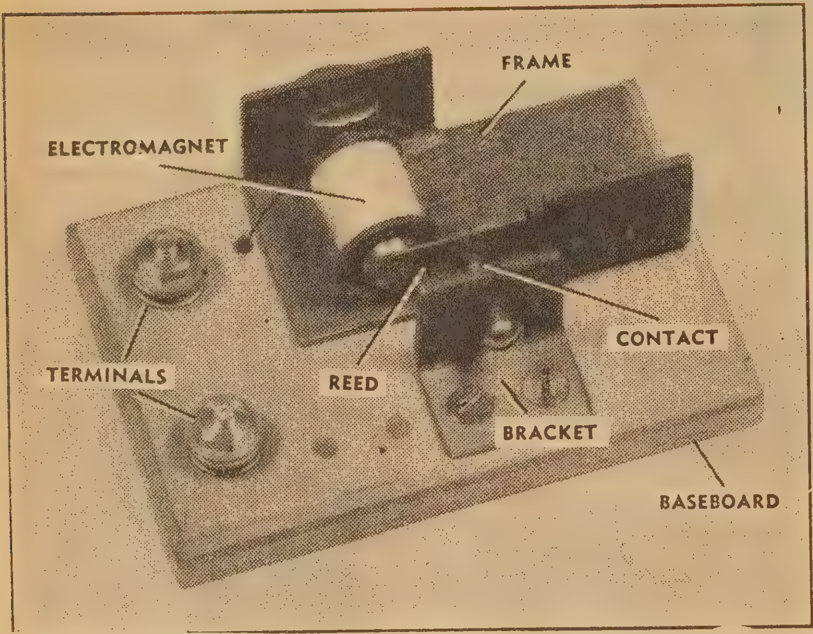
The output transformer is attractively cased, and connections brought to a circular terminal board for under-chassis connection. This board is connected for various impedances in accordance with a table attached to the side of the transformer.

The power transformer has a secondary rating of 300 volts per side, which, although slightly higher than specified for the amplifier, is not too high when used with a directly heated rectifier. Its connections also are led to a terminal strip for easy connection.

Both output and power transformer are finished in black brocade and match nicely when mounted. Constructors may use them with confidence that their results will be of high quality.

MAKE YOUR OWN ELECTRIC BUZZER

Having studied the strange powers of the electric fields, made ourselves familiar with electric currents and their relation to magnetism, we are now in a position to show you some of the very interesting and practical things that can be done with electricity. This month we show you how to make a buzzer and connect it into a signalling system.



This buzzer was made from a few scraps found in the workshop but its finished appearance does not give any indication of its humble beginnings.

WE concluded our discussion last month by showing how a magnetic field is produced when an electric current is made to flow in a length of wire. When the wire is wound in the form of a coil it produces a magnetic field of much the same shape as that produced by a bar magnet, but with the advantage that the field may be switched off and on as required. This latter feature is very valuable as you will appreciate when you study the design of the buzzer.

By winding the coil around a soft iron core it is possible to make a much stronger magnet. The iron core becomes magnetised by induction and adds to the strength of the field. You can perform an interesting little experiment to prove this.

SOFT IRON CORE

Take an ordinary iron nail (actually nails are usually made of mild steel) and around it wrap about two layers of paper. Over the paper wind two or three layers of enamelled coper wire. The exact thickness of the wire is not very important as the experiment is only to illustrate the principle involved and we are not greatly concerned if our little electromagnet is not 100 pc efficient. Use wire of about 30 gauge and wind on three layers, each layer being about ½in long.

After removing the enamel insulation from the ends of the wire, touch them on the terminals of a dry cell. If the dry cell you used last month is not completely exhausted after the "electric motor" experiments, it would be suitable. Note how, with the current flowing, the nail is capable of picking up small iron and steel objects, such as pins, paper clips and tacks, but as soon as the circuit is broken, the power of attraction no longer exists.

Now push the paper off the nail and try the effect of passing current through the coil without the nail in position. You will probably find that it is barely possible to notice the magnetic effect, proving the value of the iron core beyond any doubt.

Before pushing the nail back into the centre of the coil, place a pin on the table and try touching it with the nail. You may notice that there is a slight attraction between the pin and the nail. There is probably not enough to enable you to lift the end of the pin off the table, but sufficient to move it slightly without the pin and the nail actually touching.

by Maurice Findlay

This indicates that the nail retains a small amount of magnetism after the current has been switched off. The degree of magnetism that the nail is capable of holding depends on the hardness of the metal. The harder it is the stronger will be the resultant permanent magnet. You will remember that it was for this reason we used a piece of clock spring to make the compass needle.

Therefore, if we wish to make an electromagnet which will lose its magnetism as soon as the current is switched off, we should use a soft iron core. To make sure that a piece of iron is perfectly soft, heat it to a dull red and then allow it to cool slowly. A good idea is to place the iron to be treated among the embers of a wood fire and then allow the fire to go out.

Most electromagnets have cores of soft iron. Electric motors, electric bells and buzzers include electromagnets, which are required to be switched on and off quickly and completely, so that a soft iron core is necessary. Transformers also have a soft iron core because the magnet is required to change its strength quickly and frequently.

An electric buzzer is one of the simplest electrical devices to make use of an electromagnet. It consists of a metal reed, which is made to vibrate by an electromagnet. The electromagnet is switched on and off rapidly. The metal reed disturbs the air, causing sound waves to be radiated and heard as a buzzing sound.

By a very simple but ingenious arrangement, it is possible to arrange the electrical circuit so that the magnet switches itself off and on in synchronisation with the vibrating reed.

Note the diagram of Fig. 1, which shows the layout of a simple electric buzzer. The essential parts are the electromagnet, the reed, the contactor and the battery. Fig. 1 shows the buzzer just after the current has been switched on but before the reed has time to move.

SEQUENCE OF OPERATIONS

The electrical circuit is complete as the current is flowing from the battery, through the contactor to the reed and from the reed to the electromagnet, thence back to the battery. Since the current is flowing through the electromagnet, it attracts the metal reed toward it (Fig. 2). As soon as this happens, the electrical circuit is broken and the current no

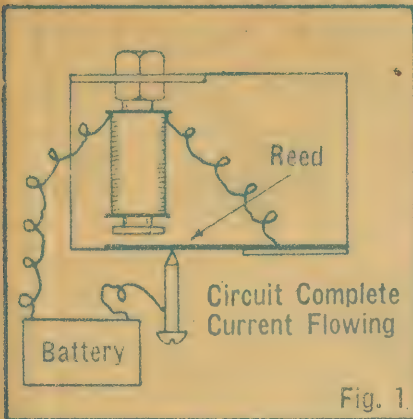


Fig. 1

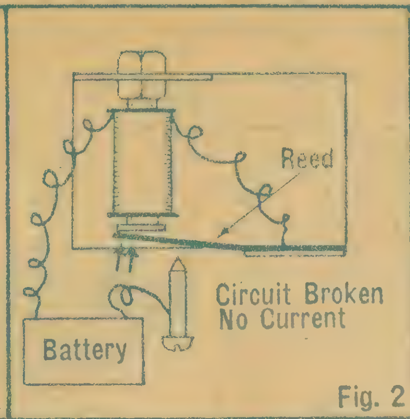


Fig. 2

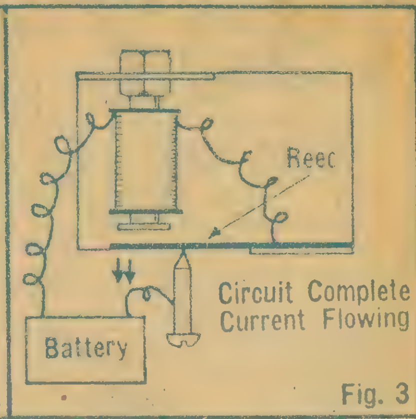


Fig. 3

The above diagrams show how the electromagnet is switched on and off automatically as the reed moves. The frequency at which it oscillates is determined mainly by the length and thickness of the reed.

longer flows, which in turn means that the reed is no longer attracted.

As soon as the attraction ceases, the reed springs back to its original rest position (Fig. 3), where it touches the contactor again. The electromagnet then becomes active again and pulls the reed away from the contactor. So the movement of the reed keeps on repeating itself as long as the battery is connected.

With a few scrap materials you can make an excellent buzzer. You may care to copy the model shown in the photographs which we made to illustrate the principle. You will need a scrap of wood, some pieces of sheet iron, a short length of clock spring, 1 3-16in steel bolt with two nuts, and a number of 1-8in nuts and bolts. If you have never made anything of this nature before, you will find the soldering the hardest part of the job, but even that is not too difficult.

From the drawing of the parts required you will note that the baseboard is a piece of wood 2in by 3in. Cut it to size and sandpaper smooth. The holes required are marked on the drawing, but it is as well to drill these after making the metal parts so that you can make them correspond exactly. Use three-ply if nothing better is available but a piece of wood, either ply or solid about 3-8in thick will give a more solid foundation and assist in keeping the contact points correctly aligned over a long period of time.

The frame to support the electromagnet, the reed, and the bracket which holds the contactor are made from scraps of sheet steel. The exact thickness is not very important, but we would suggest about 16 gauge so that the finished frame and bracket will be strong enough to give firm support to the assembly.

UNSUITABLE MATERIALS

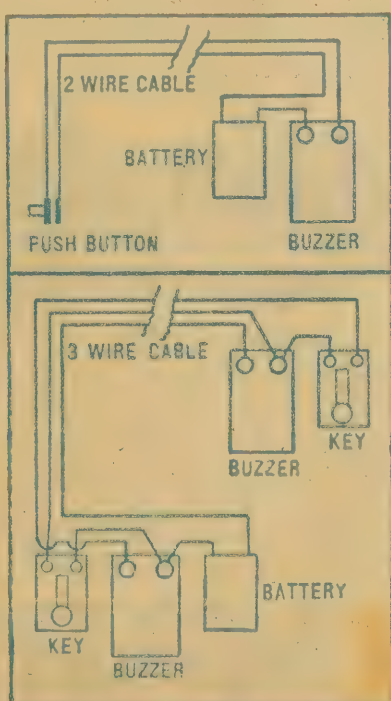
Tinplate or galvanised iron (sheet steel plated with tin or zinc respectively) is easy to obtain and you may be tempted to substitute for the thicker steel, but with such flimsy support the buzzer would not retain its adjustment for very long. Apart from this, the magnetic circuit would not be very efficient.

Mark out the outline of the parts on the metal with a sharp pencil or a scriber if you have one. Also mark the lines along which the metal is to be bent and the centres of the holes. With the metal held in a vise, cut around the outline you have marked and then file the edges smooth.

The contactor is a 1-8in bolt with the end filed to a point. It is held by a 1-8in nut soldered to the bracket you have just cut out. This enables the pressure of the contactor on the reed to be adjusted for the best and loudest note. Drill a hole slightly larger than 1-8in diam. in the appropriate position, and then solder the nut over the centre of the hole.

Just in case you are not too clear about the soldering, we will make a few remarks which will help.

First of all, clean one side of the bracket and one side of the nut with a piece of emery cloth. Then apply a smear of flux to the two surfaces.



The top circuit shows how the buzzer can be operated with a push button. You can use the same arrangement for a morse code set by substituting a morse key for the push button. At the bottom is an arrangement for a two-way signalling set.

Killed spirit may be used, but one of the non-corrosive fluxes designed for radio work is to be preferred.

Prepare the soldering iron by heating it to the correct temperature and, if necessary, re-tinning the copper bit. If the coating of solder on the bit is poor it will be necessary to file the bit until the shiny copper surface is exposed. Wipe it with flux smeared on an old piece of rag, and finally apply some solder to the bit, wiping it again with the rag at the same time to ensure a good even tinning.

Having prepared the iron, use it to tin one side of the bracket and one side of the nut. Do not use too much solder because, if the solder adheres to the thread inside the nut, it will be difficult to screw the contactor into place later. With a good even coat of solder on both the nut and the bracket, you can place the nut over the hole. The hot soldering iron placed on top of the nut for a few seconds will re-melt the solder and secure the nut.

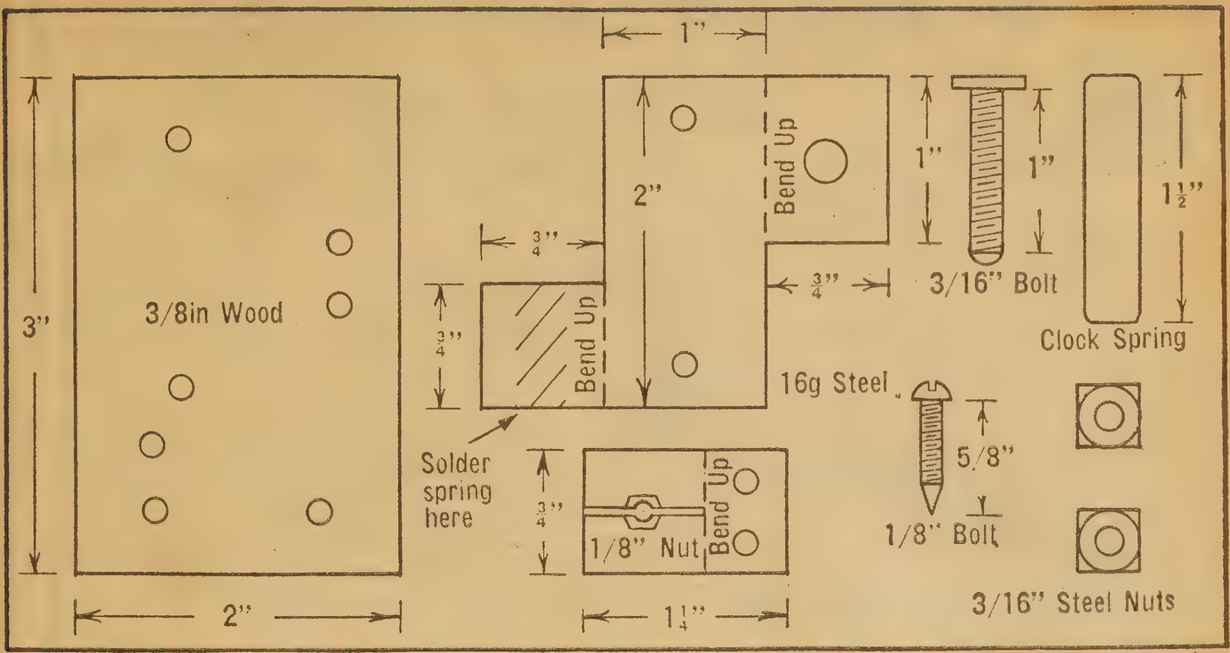
Unfortunately, neither the bolt nor the nut has perfect threads, and when they are screwed together there will be a slight amount of play. For the buzzer to work properly the contactor must be held quite firmly and at the same time be adjustable. One way out of the problem is to make a saw cut down the centre of the bracket cutting the nut in halves. Then, if you squeeze the two halves of the bracket together, the contactor will be held quite firmly and at the same time be adjustable easily.

MECHANICAL WORK

The next step is to drill the holes in the positions marked. If you centre punch the holes before drilling you will find that much less effort is required to make a clean hole in the correct position.

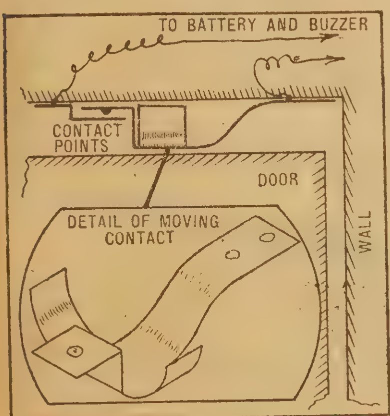
A vise will be needed to make the required bends in the frame and bracket. Place the line along which the bend is to be made level with the top of the vise and tap the metal over into a neat right angle with the aid of a hammer. At this stage, you can solder the piece of clockspring into position using the same technique as we suggested for soldering the nut to the bracket. It will be necessary to use a piece of emery cloth to remove the "blue" finish from the spring so that it can be tinned properly.

The main job now remaining is to



You will need a few 1/8in nuts, bolts and washers in addition to the above but most of the materials will be found in a scrap box.

make the electromagnet. Obtain a 3-16in steel bolt. If it has a round head file some of the metal off the head, making it the shape shown in the drawing. The purpose of the flat surface is to allow the core of the magnet to be brought close to the vibrating reed with consequent improvement in the efficiency of the magnetic circuit.



This is one way to make a contactor for a burglar alarm. You can easily work out others suitable for windows or gates.

It is also a good idea to make sure that the bolt is soft by heating it and then allowing it to cool slowly. If the bolt is capable of retaining some magnetism the difference between the force acting on the reed with the current on and the current off will be lower, with consequent reduction in the strength of the vibrations. A soft iron reed would be more efficient, too, but it would lack the springiness of the clock spring.

You are now ready to wind the coil. Obtain two 5-32in fibre washers ½in in diameter. You will find that it is possible to screw these washers over the 3-16in thread without too much trouble. Screw one right up to the head of the bolt and the other along the bolt so that there is about ½in between them. Wrap a piece of paper around the bolt between the washers to prevent the possibility of the wire touching the bolt and then wind the space between the washers with insulated copper wire until it is almost full.

Again, the exact gauge of the wire is not extremely important, but we have found that something between 30 and 35 gauge is suitable where the buzzer is to be operated from a 3-volt battery. If you have a battery of higher voltage available you could use the thinner wire to advantage.

Actually, the buzzer can be made to work from a 1½-volt battery, provided the pressure of the contactor on the reed is adjusted very carefully, but after it has been running for a while the efficiency of the contact between the reed and the contactor decreases due to sparking. A higher voltage tends to overcome this defect.

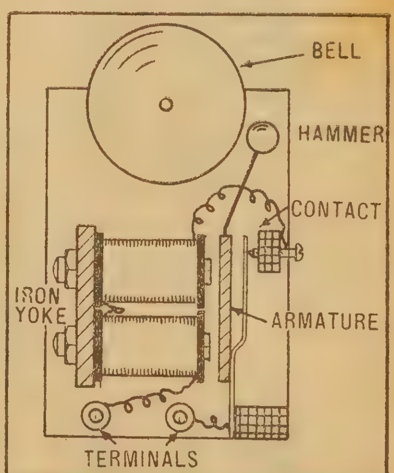
Commercial buzzers use special contacts made from a very hard metal such as tungsten, so that the contacts do not need cleaning for a very long time, but if you were to use tungsten contacts in the home-made version, it would take much longer to finish and be more difficult to make.

The various parts may now be assembled on the baseboard, and the wiring completed. The diagram which explains the operation of the buzzer also shows the wiring, with the exception that the wires which go to the battery in the diagram should be brought out to the terminals for convenience when it is desired to connect the buzzer into an external circuit. The terminals are simple 1-8in bolts which are pushed up from under the baseboard with a nut to hold them in position. Two washers and another nut make connection to the battery or signalling circuit as the case may be.

The next job is to adjust the buzzer for best performance. Connect the battery and screw the contactor until it just touches the reed which will then start to vibrate with a high-pitched note. Try several adjustments, the idea being to obtain a strong, smooth vibration. Check to make sure that the reed will start from the rest position after making each adjustment, as it is possible to make a good running adjustment only to find that the reed will not start.

PRACTICAL USES

Having made and adjusted the buzzer you will have absorbed quite a deal of practical knowledge about the operation of a simple piece of electrical apparatus. However, there



Although it contains some extra parts, the electric bell is very similar to the buzzer. The more elaborate arrangement of the magnet and armature makes for greater efficiency.

are quite a number of practical uses to which it can be put.

For example, we have shown a simple circuit which would enable the buzzer to be used for signalling. The push-button could be located

PLAYS MICROGROOVE

OR STANDARD RECORDINGS

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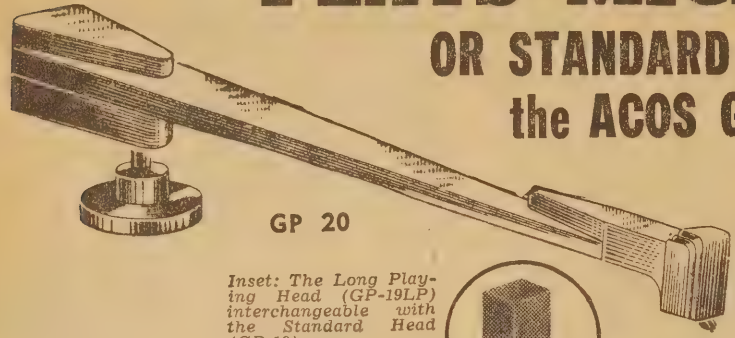
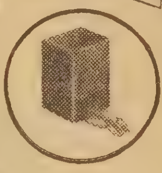


GP 20



Inset: The Long Playing Head (GP-19LP) interchangeable with the Standard Head (GP-19).

The G.P.20 pickup is designed for use with the standard 78 r.p.m. records or the 33 1/3 or 45 r.p.m. long-playing microgroove records. To meet these differing requirements, two interchangeable slide-on heads are available.

G.P.19 head supplied as standard.

G.P.19 L.P. head available for microgroove.
It is something new in pickup design and has 20 times greater output than comparable magnetic types, while needle talk and motor rumble are practically non-existent —permanent sapphire stylus—wide frequency response.

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Price—G.P.19 L.P. head £3/11/0.

Price—G.P.19 standard head £3/11/0.

GP 10

Sturdy construction, ninety degree lift back and exclusive needle pressure adjustment makes this a really outstanding unit in the field of pickups. Has a low harmonic distortion, with an average output of 1.5 volts.
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Needle pressure only ½oz. 41/6

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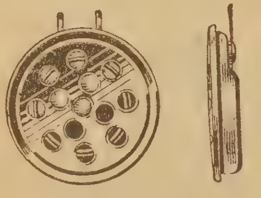
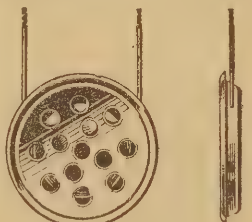


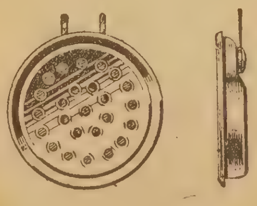
MIC 14

MIC 14 Standard Speech Microphone insert with nickel-plate brass case which gives high corosion resistance, mechanical strength and rigidity. Price 39/3.



MIC 18

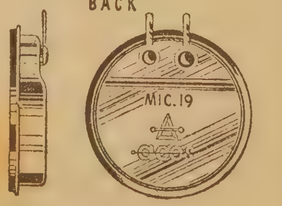
MIC 18 Microphone Speech insert provides high acoustic qualities with minimum bulk. Where exceptional slimness is required this insert is recommended. Price 39/6.



MIC 3

MIC 3 Diaphragm-Actuated Crystal microphone specially designed for the reproduction of speech frequencies. With rising response from 1000 c/s, this microphone has exceptional sensitivity. Price 39/3.

BACK



MIC 19

MIC 19 Sintercel fulfils the requirement for a flat insert with good sensitivity and a frequency response 40/8000 c/s. Unaffected by vibration, exceptionally robust construction. Price £2/19/9.

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at the front door of the house while the buzzer and battery could be placed at the back of the house, enabling visitors to make their presence known by simply pressing the button.

Another circuit shows how two buzzers may be used so that signals can be transmitted between two remote points. If you have a friend next door, you could supply him with a push-button and buzzer, and by a pre-arranged system of signals, send messages to each other. An even better idea is to use Morse Code keys at either end in place of the push-buttons.

If you wish to learn the Morse Code, this is an excellent way to begin, especially if your friend at the other end is also anxious to learn. It only takes a couple of days to memorise the letters so that you can start sending messages to each other at a slow speed quite soon. Practice over a period of time is required before high speed can be achieved, but this is a good way to get it. If you would like some more information, we still have a few copies of the 1950 edition of the Australian Shortwave Handbook, which we can forward to you, at a cost of 2/-, post free. The handbook contains an excellent article on learning the Morse Code.

ELECTRIC BELL

An electric bell is very similar to a buzzer, although it requires a few extra parts and is a little more difficult to make. However, the bell can be designed to make a much greater sound that the buzzer, and, is therefore, more suitable for a signalling system between a front door and the back of a house for instance, or a burglar alarm.

The essential difference is that the moving parts are heavier, so that they vibrate at a much slower rate and the sound comes from the gong rather than from the vibrating reed. Just in case you would like to try making a bell after finishing the buzzer, we have included a diagram showing the general arrangement.

To make the magnetic circuit very efficient, a soft iron armature is used and the electromagnet is made in two sections, which are wired so that the two ends of the magnet adjacent to the armature are of opposite polarity.

A heavy armature would have caused the buzzer to sound a very low and not at all pleasant note, but this does not matter in the case of the bell, since the sound from the bell itself, is very much greater than the sound from the reed.

There is plenty of scope for ingenuity in designing burglar alarms. The idea is to arrange a circuit, so that when a door or window is opened a contact is closed, allowing the current to flow through the bell. We have shown one simple form of contacter which can be fitted into the small space which usually exists at the top of a door. The parts can be made from tinplate in a matter of minutes. Of course, this is only one suggestion and you can probably think of another form of contacter to suit a particular door or window.

Again, pursuing the subject from a practical angle, next month we will discuss the construction of an electric motor. The motor can be constructed with a few ordinary tools and scraps of wood and metal.

SAFETY FIRST IN THE WORKSHOP

Practically every workshop accident could be avoided if every workman were to take a little time to think about safety first in the use of tools. If somebody takes a hammer and deliberately hits himself on the thumb with it there is very little that can be done to help him, but it is almost as bad to ignore the elementary rules of safety.

THERE is no more important safety device in any workshop, whether it be large and equipped with modern machinery, or just a six by eight backyard shanty, than a careful workman.

All the care in the world is no use if he does not understand his equipment. Whether it be a screw cutting lathe or a 10in flat file there is always something to be learned about its use. Always aim to make tools your servants. You must know your servants well.

For example, did you know that some nasty accidents have been caused by people hitting files with hammers? Files are made from hard material, which is at the same time very brittle. A blow with a hammer in the right direction will send a jagged piece of file into your flesh with the speed of a bullet.

For the same reason never use a cold chisel with a burred head. To be on the safe side, grind a small chamfer all around the head before using.

Before using the hammer, check to make sure that the head is securely in place.

Every file should be fitted with a secure handle. It is surprising how easy it is to push the tang of file through your hand.

Before attempting to tighten a nut, make sure that the spanner fits correctly. Spanners which fit incorrectly may slip, with painful results.

When drilling with an electric drill always hold the work in a vice where possible. If the drill happens to catch in the work it is always easier to control the drill than it is to control a piece of sheetmetal, for example.

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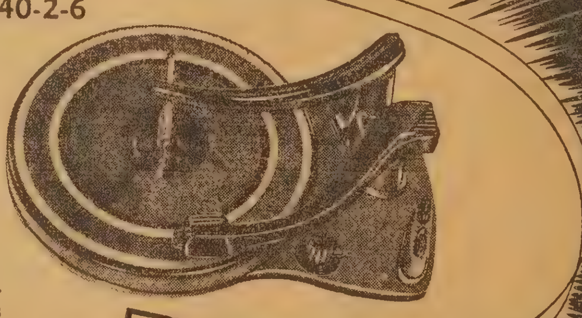

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A COURSE IN TELEVISION

(Continued from Page 71)

(b) Since the intercarrier system depends upon both carriers for its sound reproduction, it is evident that momentary disappearance of the video carrier, such as might be caused by over-modulation of the transmitter, also causes interruption of the sound.

By imposing the limitation at the transmitter that the picture carrier shall never fall below 10 or 15 pc of the maximum amplitude, the possibility of such sound "break-up" is prevented.

Another effect which has symptoms very similar to sound break-up by video carrier disappearance is that occasioned when one of the video IF amplifier stages is driven to cut-off, as it is sometimes possible to do by improper adjustment of the contrast control.

NOT SERIOUS

Since the peak signals are the "sync" pulses, which are in the infra-black region, this type of operation is not necessarily deleterious to the performance of the ordinary dual IF sets. In the Parker system, however, operation at cut-off results in sound break-up.

(c) Failure at the transmitter to maintain accurately the 4.5 mc spacing between the video and audio carriers results in the same kind of audio performance degradation as that caused by misadjustment of the tuning control or discriminator circuit in the conventional dual-IF system.

Whereas this condition can easily be corrected by the user of the older system by adjustment of the fine-tuning control, the intercarrier arrangement must depend upon the broadcaster for the correction of this condition.

(d) The effects of drift in the discriminator circuit of the intercarrier sound system are usually slight, since the sound sub-IF is at a relatively low frequency and can be virtually eliminated by careful design and the judicious use of small fixed capacitors having the proper capacitance versus temperature characteristics.

Figs. 4 and 5 show the overall response curves for the two TV systems discussed above. The only difference lies in the shape of the curves in the vicinity of the sound portion of the spectrum. In the dual-IF system, full response over at least a 25 kc band-width, centred on the sound "resting" frequency is desired while, in the intercarrier method, the sound acceptance notch is in the form of a small shelf of similar width and centre frequency.

"PLATEAU"

The reason for a plateau rather than a gradual roll-off for the intercarrier sound response is that in this way partial demodulation of the FM sound by slope detection, and possible picture interference is prevented.

As shown by Fig. 5, the response at the sound shelf should not exceed 5 pc of full amplitude. This, as mentioned earlier, reduces the video amplitude modulation of the sound sub-IF to a negligible value and also prevents possible distortion of the picture by the sound modulation.

The sound trapping requirements in the Parker system are not nearly so stringent as in conventional sets. A single trap, providing about 26 db of attenuation is required immediately preceding the video detector to reduce the sound response to the 5 pc level. This rather large attenuation is subsequently compensated for by the additional gain of the one or two video amplifier stages.

In closing, it may be remarked that the results of rather extensive field tests, and the likelihood of industry-FCC co-operation in setting up the transmission standards necessary for insuring satisfactory performance, may well lead to the eventual complete adoption of the intercarrier ystem for television sound reception. (By courtesy Aerovox Corporation.)

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Thunder and Lightning

(Continued from Page 15)

neutralised. These cloud flashes occur in clouds which are too high for the lightning to take the shortest path and discharge to earth.

When the heavily-charged cloud discharges to ground it gives rise to a terrific flash of great intensity.

The usual flash to ground consists of a double stroke. The first stroke is called the "leader" and is faintly luminous as it passes from the cloud to the ground. The most brilliant portion of the flash is the return stroke from ground to cloud. This stroke follows the path of the leader, but in the reverse direction.

The "leaders" travel at a speed from 186 to 1860 miles per second, while the return flash from ground to cloud is much faster, reaching a speed of some 18600 miles per second. It is interesting to note that these speeds are in fractions of the speed of light.

The lightning flash does not travel in a straight line, but advances in steps, each step being in a different direction to the previous one.

Each step is about 50 yards long, and there is a distinct pause between each which has been measured, and found to be about 50 micro-seconds. It is from the intersections of these zigzag steps that branches take place, giving rise to forked lightning. And lightning only forks in a downward direction because it is a downward "leader" streamer which produces them.

The zigzag nature of a lightning flash is explained by the fact that the discharge must take advantage of every weakness in the condition of the air in order to reach the ground. The flash follows the line of least resistance as it were, and this is rarely straight in a continually variable atmosphere.

RETURN STROKE

Immediately the "leader" strikes the ground, the return stroke takes place. If anything, it begins to return before the leader hits, and joins the leader about 30ft above the ground with a burst of flame, continuing its upward path along the same route taken from the cloud by the leader. The return streamer actually illuminates the branches and forks formed by the leader on the down journey, just as if the air has not recovered its stability in the intervening period.

A reader from Mareeba in Queensland has mentioned about a fireball which struck the earth near Mareeba and wishes to know all about this phenomenon.

This is a "phenomenon" which has often been reported as having been seen, but the very latest information from authentic sources has shown that, although professional meteorologists have watched tens of thousands of lightning flashes, none of them have seen a "fireball."

The accounts given by those who have claimed to have seen one give the size as anything from ½in to 6ft in diameter. Colors range from white to red, yellow and blue. It is supposed to bounce around rooms and sometimes to burst with a loud report.

The fact is, nothing is known about them, and from a scientific point of view, they do not exist.

In most of the accounts examined, the "ball" was seen either at the moment or just after a close lightning flash. It is thought that the phenomenon is caused by an optical illusion, because when the retina of the eye is dazzled by such a close flash, if seen from the corner of the eye, it retains for a fraction of a second an image in the form of a ball of light.

"ST. ELMO'S FIRE"

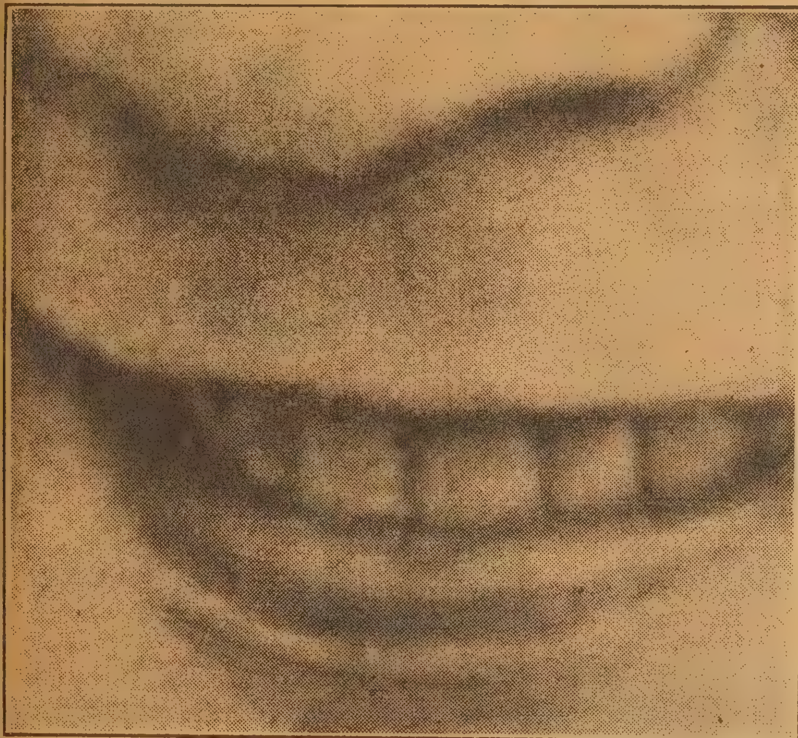
Some cases reported have, on investigation, been found to be nothing more than a manifestation of "St. Elmo's" fire. This is a glow usually seen at the ends of pointed insulated metal when in close proximity to an electric conductor. It is brought about by ionisation of the surrounding air similar to that which takes place in a neon tube.

From hundreds of reports investigated not a single authentic observation has been found. I am sorry.

Space will not permit of a more detailed discussion of the many other interesting facts about the fascinating subject of thunder and lightning, but perhaps at a later date we will resume our study. In the meantime a Happy and Prosperous New Year to all my readers. Let me know what subjects you are interested in, and I will do my best for you. Cheerio.

TO save time when cutting a number of short lengths of string for tying labeling tags, use a piece of cardboard and a paper cutter of the type used for trimming. First cut the cardboard to a width slightly more than half the required string length. Then wrap the string around the cardboard, anchoring the ends in slots cut in the cardboard. Trimming about ¼in from one edge of the cardboard will cut as many short strings as there are wrappings around the cardboard.

SUITABLE NEGATIVES TO ENLARGE



How excessive enlargement shows up grain. The original print showed much more grain than is visible in the reproduction, due to the limitations imposed by the block screen, but it does give good idea of grain structure.

What are the most serious defects in a negative which spoil an enlargment? In this article we discuss some of the problems of grain and camera shake and methods which may be used to overcome them.

by Philip Watson

SO far we have discussed the main reasons why it is desirable to enlarge the negatives from most modern cameras and also the means by which this is achieved. But we have said little about the negative itself, having more or less assumed, for purposes of discussion, that this link in the chain was perfect.

In fact, there are quite a number of reasons why this is not so, some of which are directly attributable to the limitations of the negative material and some to the way in which it is used—or abused.

GRAIN

In the former category the most important single factor is probably that of grain, which is the main one affecting the resolving power of the emulsion.

The grain of a negative is due to the fact that the image is not a solid, opaque mass as it appears to the eye, but is made up of a very large number of tiny grains of silver, very much in the same way as the half-tone reproductions in Radio and Hobbies are made up from small dots.

The grains of silver are very much smaller than the dots in a half-tone screen and, in fact, are only visible when subject to considerable enlargement. If the size of the individual grains were the only factor it is doubtful whether the subject of grain would have received so much attention, for they are so small that most ordinary degrees of enlargement would fail to reveal them.

The real trouble is due to the grouping or clumping together of several individual grains to form what is, in effect, one big grain. It is only in recent years, mainly since the advent of the electron microscope, that the real importance of grain clumping has been realised, thus enabling scientists to make a better approach to the whole subject.

It seems that when a group of individual emulsion particles, or potential grains, are crowded together and one of them is effected by light there is every chance that all the rest of the grains in that group will ultimately develop as though they also had been exposed. This means that the fine point of light is not reproduced as such but as a relatively large area, possibly intruding on adjacent detail and effectively reducing the resolving power of the emulsion.

When a negative is enlarged excessively the grain structure is revealed as a mottled pattern which tends to break up fine detail which might otherwise have been recorded. In most cases, by careful attention to all the governing factors, it is possible to keep the resolving power of the emulsion on a par with that of a high-quality lens. However, this last statement is a rather general one and it must be realised that, whereas the resolving power of a lens is usually retained as the coverage is decreased, such is not the case with an emulsion, and the grain problem becomes more and more acute as the size of the negative is decreased.

CONTROL OF GRAIN

There are many factors affecting the amount of grain which will show in the finished print, including the initial choice of the grade of film, the exposure, choice of developer and method of use, and, finally, the type of paper on which the print is made.

At first it might seem natural to make all emulsions with the finest possible grain but the fact is that this characteristic is necessarily a compromise with the speed of the emulsion, fast emulsions having coarse grain and slow emulsions fine grain. It, therefore, becomes necessary to select your emulsion according to the job it is to do and taking into account the amount of enlargement which will be necessary to make a satisfactory print.

Thus the user of a 2¼in x 3¼in camera does not normally need to worry over much about grain for his negatives will, in most cases, only require two or three diameters enlargement and this is not sufficient to reveal it. In these circumstances the use of a fast emulsion, such as a Kodak Super XX or Ilford HP3, is fully justified and the added convenience is well worth while, the problem of grain only presenting itself on those rare occasions when a very small section of the negative is to be enlarged.

35mm PROBLEMS

At the other end of the scale the 35 mm user is waging a constant battle against grain and usually finds it best to concentrate on the slower but very much finer grain emulsions, using the faster types only when conditions make them absolutely essential. Since it is seldom convenient to change spools in the middle of a roll it is often necessary to simply accept the limitations of which ever type happens to be in

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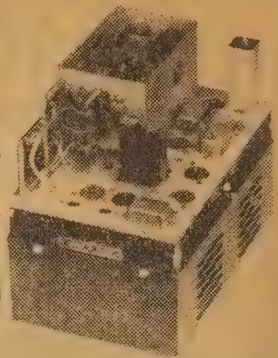

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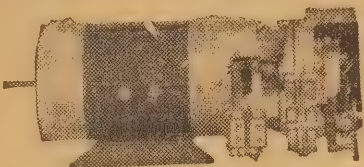

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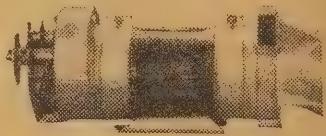

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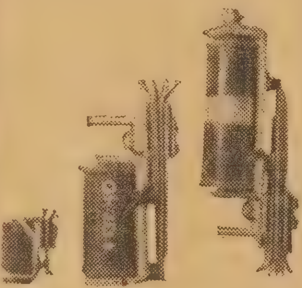

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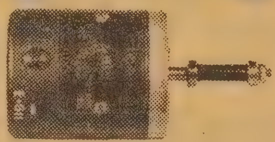

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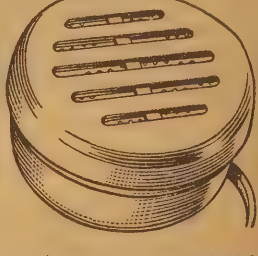

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AT TOP OF TAVERNER'S HILL

the camera. Typical of modern fine grain emulsions are Ilford FP3 and Kodak Panatomic-X.

Exposure has a marked effect on grain, over exposure tending to aggravate the condition, and the minimum grain occurs when the exposure is just sufficient for the prevailing light. For this reason the full latitude of the film, so useful when the exact exposure may be in doubt, can not be made full use of when large degrees of enlargement are required.

Next comes the question of development and the part which it can play in minimising grain. Unfortunately there have been many claims in the past claiming that one concoction or another was the solution to the grain problem, many accompanied by extravagant statements about increasing the speed of the film at the same time.

When the formulas for these patent "brews" were examined by independent and unbiassed photographic chemists they were found to differ very little from more standard arrangements and, quite naturally, the results they gave were exactly what would be expected, that is, differing in no marked degree from those produced by standard formulas. The claims of increased speed were proved, by carefully controlled tests, to be quite groundless.

EFFECT ON SPEED

The fact is that, at the present time, all developers which have been designed to minimise grain have some adverse effect on the speed of the emulsion. In many cases this is only slight, so much so that it can be ignored, while for others (of the ultra-fine grain type) it might amount to a full stop opening, or nearly the difference between a fast film and a fine grain one.

Thus one may use a moderately fine grain developer with a fine grain emulsion without loss of speed or an ultra fine grain developer with a fast film and suffer a loss of speed as a result. In either case the resulting film speed and grain would be much the same so there is not a great deal to choose between them, except that some of the ultra fine grain solutions are very toxic and can give rise to severe skin irritation.

The general trend at the present time is to use one of the moderately fine grain developers which are designed to give the finest possible grain without any appreciable loss in emulsion speed and select a grade of film best suited to the particular conditions. A typical example of this type of developor is Kodak Microdol.

MINIMUM DEVELOPMENT

The period of development also has an effect on grain, prolonged development tending to increase the grain, so that the final development time is usually a compromise between adequate contrast and minimum grain. Most commercial fine grain developers carry instructions to this effect, together with details of the optimum development time. If it should be found that these times are insufficient for your particular requirements they can, of course, be increased, but only at the expense of increased grain.

The beginner who has had little practical experience in this kind of work will naturally want to get some idea of how much enlargement is possible, assuming the correct use of one of the moderately fine grain developers. It is impossible to give exact figures since, as already pointed out, there are many factors other than the developer and film to be considered.

One of these which we have not so far discussed is the size of the final print. This controls the effective degree of grain by controlling the distance at which the print will be viewed. An outsize print, such as seen at photographic exhibitions, has not been made so large in order to reveal hidden detail, but rather to enable a large number of people to view it at the same time with relative ease. In this case the viewing distance would be several feet and the effective size of the image to the eye would be no greater than that produced by a much smaller print seen at the more normal viewing distance of 10 or 12 inches.

Thus the 20 diameters or so which may be quoted as the enlarging factor of such a print really does not mean very much in terms of grain, for the grain may be readily apparent when it is viewed too close.

SIZE OF PRINT

On the other hand if we were to apply the same degree of enlargement to a very small section of the negative and thus produce only a normal sized print, this would be viewed at a normal distance, and the grain would appear excessive as a result.

Perhaps the clearest idea of what can be done, can be judged from the fact that a fast film, developed in a normal fine grain developer, will begin to show slight grain at a viewing distance of about 10 inches when enlarged about six diameters. If we enlarge the whole of a 35mm. frame by this amount we will have a print six by nine inches or near enough to the standard eight by ten print, which is quite large enough for normal viewing.

However, it is seldom that the whole of the negative area is required, and, in fact, it is the ability to select only the wanted section of a negative, which makes the enlarging process so valuable. Nevertheless, the use of sections of the negative appreciably less than the whole will usually lead to grain problems, at least in the 35mm size, and every effort should be made when framing the picture to avoid waste of the negative area and work as close to the subject as conditions will permit.

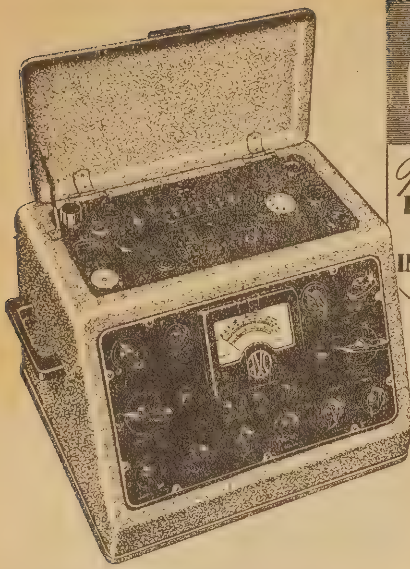
CHOICE OF FILM

Because there is always a good chance that these conditions will be unfavorable, many workers prefer to use the fine grain emulsions for 35mm work, thus providing a margin which permits large prints to be made from sections only of the negative. The fact that the advantage of the faster film is lost must be regarded as part of the price one has to pay for the convenience of a small camera, but in any case the speed of the fine grain film is still adequate for all normal working, though it may be found wanting on odd occasions when the lighting is particularly poor.

Larger negatives will, on the average, present less problems in this regard, as an enlargement in the order of three or four diameters is usually sufficient to provide a large enough print even from sections of the negative. At the same time there may be occasions when you cannot approach as close to your subject as you would like, and, if there is plenty of light, the use of a fine grain film may make all the difference between a grainy picture and a clear one.

PAPER SURFACE

It was stated earlier that the type of paper on which the print was made affected the amount of grain, and this is so to the extent that certain surfaces, particularly the



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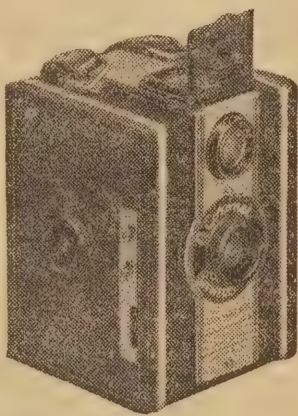

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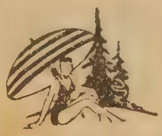


AT ALL CHEMISTS and PHOTO STORES

Australian Agents, H. Bleakley Photographics, 397 Kent St., Sydney.

rougher types, tend to mask fine detail. In this way they also tend to mask the grain pattern, but there is a very definite limit to the extent to which this is possible. The use of a glossy paper will make visible the finest possible detail, while the same is true to a lesser extent of other smooth surfaces. When such a surface makes visible a slight grain pattern this can often be disguised with the rougher surface and may result in a more acceptable print.

Leaving aside the negative material itself, there are many other defects, which show up in a negative, and which will adversely affect the quality of the final print.

The most important of these—every bit as important as grain, though seldom given as much attention—is camera shake. At its worst it is easily recognised for what it is, even without enlargement, and the negatitve is written off without hesitation. In its more insidious form, however, it is not so easy to pick, the degree of blurring being hard to detect in the negative, but resulting in a disappointing lack of detail in the enlarged print — an effect which may easily be mistaken for lack of definition in the taking lens.

IS IT SHAKE?

This latter mistake is a very common one, many enthusiasts being unable to understand why a good quality lens fails to come up to expectations, or why it appears to perform extremely well on odd occasions, but for the most part gives only mediocre results. Invariably, in such cases, it will be found that all these problems disappear as soon as the camera is mounted on a firm support, probably giving the lens a chance to really show its worth for the first time since it left the makers.

Careful examination of a suspected case of shake, either by extreme enlargement or with a high-powered glass, will usually confirm the suspicion by revealing double or multiple images of points of fine detail, such as individual blades of grass or fine horizontal or vertical lines. It is even possible to work out the direction in which the camera moved and, in so doing, may give a clue as to the cause of the movement. For example, a consistent downward movement may well indicate that the shutter release is either too stiff or awkwardly placed or simply that some practice is necessary in order to avoid jerking the camera.

Unfortunately, it is not usually as easy as all this, and the unpleasant fact must be faced that it is almost impossible to completely eliminate this trouble when the camera is held in the hand. All the old tricks, such as holding the camera tightly against the body, holding the breath while making the exposure, &c., are very valuable, in fact essential, but they will not provide a complete cure.

DIFFICULT PROBLEM

You may well ask, "How does the box camera user get away with it. He never seems to take any elaborate precautions?" The answer is that he doesn't—but the effect is usually masked by the naturally poor definition of the lens, plus the fact that the image is seldom enlarged, and that a high standard of definition is not expected anyway. In fact, the product of the average button presser does not even do justice to the simplest equipment, and more than one box camera user has received something of a shock when shown the results of a firm support under a cheap camera.

The fact that as cameras become more compact and convenient they also become lighter in weight is another factor which aggravates this trouble for the lighter unit is very much harder to hold steady.

All of which simply adds up to the fact that camera shake is far more prevalent than is usually realised—or at any rate admitted—and so-called freedom from the trouble is often merely relative rather than complete.

SHUTTER SPEED

It is often thought that a high shutter speed is an automatic cure, but this is really only a half-truth. Many instruction booklets advise the use of a firm support for exposures longer than 1-25 of a second, and, probably for this reason, it is often imagined that any speed shorter than 1-25 can be safely held in the hand. In fact, speeds of 1-300 of a second are not sufficient to entirely eliminate the trouble, although a much higher percentage of good negatives will usually result from the use of such speeds.

This fact may be very useful in tracking down lack of definition for, if it is found that those negatives taken at high shutter speeds are consistently better in quality than all others, it can be confidently assumed that shake is the cause of the trouble. I have even known fellows to claim that their lens gave better quality at full aperture than it did when stopped down, whereas what was really happening was that they were using a full aperture only when they needed a high shutter speed, and this was improving the definition by minimising the shake.

The real problem, once the user has been convinced that this is really the cause of the trouble, is now to eliminate it, for it is impossible to turn out high grade work while the trouble persists. The use of a good tripod will almost certainly be effective but there are many occasions when the use of such a device is undesirable or even impracticable.

The average user prefers simply to carry his camera and perhaps a few minor accessories, such as filter and exposure guide, and is inclined to jib at the suggestion that he load himself down like a pack horse. He reasons, and perhaps logically, that if he has to carry all that gear

(Continued on Page 95)

SHORT WAVE NOTES BY RAY SIMPSON

100kw TRANSMITTER FOR RADIO SWEDEN

Mention has been made before of the proposed new transmitter to be used by Radio Sweden and according to the latest advice received from the station through the World Radio Handbook, this transmitter is expected to come into operation early in 1952. As the old 12 kw station at Motala has been heard in Australia for a long time now there should be no difficulty in receiving these new transmissions considering the greatly increased power to be used.

THE following schedule is expected to come into operation from January 15 to February 28, 1952:—

10.0 am to 12.45 pm, on SBO, 6.065 mc, beamed to the East Coast of the USA; 1.0 pm, to 1.45 pm, on SBU, 9.535 mc to East Africa; 2.0 pm to 2.45 pm, on 9.62 mc, to India and Indonesia, and on 9.535 mc to South Africa. From 9.0 pm to 9.45 pm, on 21.58 mc, they are directed to South America, and from 10.0 pm to 10.45 pm, on 11.88 mc, to the East Coast of the USA. From 11.0 pm to 11.45 pm, on 9.535 mc, directed to the Far East and the Pacific, and from midnight to 2.0 am, on 9 535 mc, to India and Indonesia. They are on again from 3.0 am to 3.45 am, on 9.535 mc, to South Africa, and from 7.0 am to 8.0 am, on the same frequency, directed to the West Coast of the USA. They revert to the 49-metre band from 9.0 am to noon, when they use 6.095 mc to South America.

A further afternoon programme can be heard from SBU from 3.0 pm to 4.0 pm, when the program is intended for South Africa.

Unidirectional transmissions of the Home program will be carried out at 3.0 pm to 7.0 pm on SBO, from 7.0 pm to 3.0 am over SBP, on 11.705 mc, from 3.0 am to 9.0 am on SBO, and finally from 5.0 am to 6.45 am on 6.095 mc.

Readers will notice there are four new frequencies to be used, namely, 6.095 mc, 9.62 mc, 11.88 mc, and 21.58 mc, but at this time we cannot say what the call letters will be, though these may be announced when the new transmitter takes the air. Reports on these new transmissions should be addressed to Radio Sweden, A/B. Radiojanst, Stockholm 7, Sweden.

RADIO MERITERRANEO VALENCIA

THANKS to our Victorian listener, Mr. A. Talbert, we are able to give details of a recent verification he received from Radio Mediterraneo. They sent a very nice letter in English, which reads as follows: "We had the pleasure of receiving your reception report dated 23rd March, 1951, and we thank you very much for it. As a matter of fact, this station is the only one that broadcasts the Hacia Valencia and the Marcha de la Ciudad, and our wavelength is as you quote, 7.037 mc.

We hope you will be able to tune again our broadcast in the near future, as do other listeners in your country. Awaiting to hear from you again very soon, we remain, very faithfully yours. Signed, T. Mayans Marco."

DZH9 MANILA NOW ON THE AIR

IN last month's issue we mentioned that it would appear that the Far East Broadcasting Company would soon take into use their outlet in the 25-metre band. Since that time the station has now taken the air and is operating as DZH9 on 11.855 mc. It can be heard quite well after VLA11 and Oslo leave the air at 10.0 pm. The station advises that all correct reports are verified by cards and incorrect reports acknowledged by letter.

Those listeners who are stamp collectors will be interested to know that the station will send stamps of the Philippines Republic to any listener who requests them. A mailbag session is broadcast on all frequencies daily at 10.30 am, which unfortunately is not a good time for reception in eastern Australia.

SHORT Wave Notes for the February issue are due on January 5. For the March issue they are due on Feb 9. Please send them direct to Mr. Ray Simpson, 80 Wilga Street, Concord West, N.S.W.

S.W.L. CARD COMPETITION

AS it is some time now since we have given any details of short wave competitions, listeners may be interested to have details of one which is being conducted by an English radio club. The club in question is the International Short Wave Club, of 100 Adams Gardens Estate, London, SE16, and the competition invites listeners, members and non-members, to send in a typical report to an amateur radio station or a short-wave broadcast station. The idea is to obtain a standard of short wave listeners' reports the world over and entries should be forwarded to the above address. Even though entries do not arrive in time for the competition, they will still be of great use to the club.

STATION ADDRESSES

YVMG	Radio Popular, P.O. Box 247, Maracaibo, Venezuela.
YVMQ	Radio Barquisimeto, Apartado Postal 76, Barquisimeto, Venezuela.
CXA2	Radio de Montevideo, Compania Uruguayos de Publicadad, S.A., Yi 1383, Montevideo, Uruguay.
CXA3	Radio Ariel, 18 de Julio 1460, Montevideo, Uruguay.
HC2AM	Radiodifusora Cenit, Boulev. 9 de Octobre 608, Guayaquil, Equador.
HC1AC	La Voz de la Democracia, Calle Caldas 501, Apartado 388, Oriente, Quito, Ecuador.
HJCW	Radio Sud America, Correo 8a No. 11-57, Bogota, Colombia.
HJCF	La Voz de Bogota, Apartado 312, Bogota, Colombia.
ZYB7	Radio Difusora Sao Paulo, Emisoras Asociados, 7 rua de Abril, Sao Paulo, Brazil.
PRA8	Radio Clube de Pernambuco, Avenida Cruz Cabuga 394, Recife, Brazil

FLASHES FROM EVERYWHERE

BRITISH HONDURAS: Here is a Central American country which has been operating a short wave station for many years, but as far as we know it has never been received in Australia. Their normal outlet is 10.6 mc, where they are supposed to be operating from 11.0 pm to 3.45 am, though most overseas reports only give their time on the air as half an hour.

It has now been reported by a Swedish listener that ZIK2 has moved to the 60 metre band and is broadcasting two hours daily, from 10.0 am to 11.0 am, and from 4.0 am to 5.0 am. According to a letter from a resident of Belize, the capital, the station is not very dependable in the starting or closing times of their transmissions. Keep a look-out for them if you are listening around 4.30 am.

CHINA: From one of the latest issues of Sweden Calling DX-ers, and also from the NZ DX Times, we learn some details of Chinese schedules. Radio Peking now broadcasts on 6.1 mc and 10.26 mc from 6.0 pm to 7.25 pm, 10.0 pm to 10.30 pm, and 7.0 am to 8.30 am. On 7.5 mc from 6.0 pm to 6.30 pm, and 10.0 pm to 10.30 pm. On 9.4 mc from 10.0 pm to 10.30 pm and on 11.69 mc and 15.6 mc, from 7.0 pm to 1.30 am, 7.0 am to 7.30 am, and 8.0 am to 11.30 am. Finally, on 15.17 mc, they are on from 6.0 pm to 6.30 pm, 7.0 pm to 7.25 pm, 10.0 pm to 10.30 pm, and 8.0 am to 8.30 am.

Programs in English are broadcast at 7.0 pm and 8.0 am on 6.1 mc, 10.26 mc, 11.69 mc, 15.6 mc, and 15.17 mc, and at 11.30 pm on 11.69 mc, and 15.6 mc. Free China, on 11.8 mc, can be heard in English at 5.0 am.

ALBANIA: From overseas publications we heard of two new stations in this European country. The first one is "Radio Korca," which has begun transmissions on 8.1 mc, with a schedule of 4.0 pm to 5.0 pm, 10.0 pm to midnight, and 2.45 am to 7.0 am weekdays, and 3.30 pm to 5.30 pm, 9.30 pm to midnight, and 2.45 am to 7.0 am on Sundays.

According to a report in the Radio Tirana magazine, Radio Flores is broadcasting on 35 metres (exact frequency not known), from 3.0 pm to 4.0 pm, 10.0 pm to 11.30 pm, and 3.30 am to 7.0 am. Radio Tirana is currently reported to be operating on 7.853 mc from 3.30 am to 7.0 am, with English at 6.15 am. They are also on 8.215 mc 4.0 pm to 5.0 pm, 10.30 pm to midnight, and 4.30 am to 6.0 am.

ITALY: Present schedule of Radio Roma is as follows:—To Pacific, on 15.12 mc, 15.4 mc, 17.77 mc, 17.8 mc, 21.56 mc, from 7.0 pm to 7.55 pm. News in English, on 17.8 mc and 21.56 mc, at 8.45 pm. To South America, on 9.57 mc, 9.71 mc and 11.81 mc, from 8.15 am to 8.55 am. To Latin America, on 9.57 mc, 9.71 mc, 11.81 mc, and 11.9 mc, 11.0 am to 11.55 am. To North America, on 11.9 mc and 15.4 mc, from 10.0 am to 11.25 am. To South Africa, on 15.4 mc and 17.8 mc, from 6.5 am to 6.35 am. To Africa and Near East, on 11.9 mc and 15.4 mc, 3.20 am to 3.55 am. To Pakistan and India, on 11.81 mc, 15.32 mc, 17.77 mc, 17.8 mc, 21.56 mc, from 1.0 am to 2.0 am. To Afghanistan and Iran, on 15.4 mc and 17.8 mc, from 2.50 am to 3.15 am.

MISCELLANEOUS: The Radio Club of Angola at Luanda has been testing on 11.87 mc, from 6.0 am to 6.30 am. The Mauritius station, at Forest Side, has again changed frequency, having found 15.109 mc unsuitable. They are currently broadcasting on 15.1 mc at same times as before. Radio Nepal, at Kathmandu, is now on the air from 6.20 pm to 7.50 pm and 11.20 pm to 12.50 am, with English at 11.45 pm. OXI, in Greenland, has been reported heard on 7.145 mc, from 10.0 am to 10.45 am, but this time is unsuitable for reception in Eastern Australia. In a letter from the station, Radio St. Denis in Reunion state they are on the air 12.45 pm to 1.45 pm, 6.15 pm to 7.10 pm, midnight to 1.0 am, on 4.797 mc and 7.17 mc. We are indebted to Radio Australia and Sweden Calling DX-ers for much of the above information.

THE HAM BANDS WITH BILL MOORE

Field days provide the personal contact for radio amateurs who in country areas are often only known to each other over the air. They are becoming increasingly popular as evidenced by the attendance at the Woy Woy, NSW, event.

IN glorious weather on Sunday, November 18, 240 persons from all over the State assembled at Woy Woy for the annual field day of the combined Hunter and Sydney groups of the WIA.

Visitors included G3GVN, VK5WQ, VK3AKS, North Coast zone officer VK2AHH, 2LR, 2OY and 2DY, and a group from Wollongong. In all, 112 amateurs, over 10 pc of the NSW ranks were present.

After the official opening by State president John Moyle, VK2JU, just after 11 am, the morning session was spent in general rag-chewing interspersed by competitions. Results of the latter were as follows: Radio Amateur Quiz, eight questions, Technical and General; winner: Jack Francis, VK2OF, and in second place stalwart Jim Cowan, VK2ZC; the prizegetters were closely followed by Brian Anderson, VK2AND, and Jack Hill, VK2ADT. The quiz was conducted by Vaughan Wilson, VK2VW.

Maurice Butler, VK2AAN supplied the L/C circuit that had the company guessing as to its resonant frequency—55 mc/s. It was no worry to Harry Hawkins, VK2YL, however, he nominated the exact frequency, while Jack Francis, VK2OF, suggested 51.1 mc/s and they won prizes. Bill Macgowan, VK2MQ, 54.0 mc/s, and Alf Barnes, VK2CE, 56 mc/s, were both close, too.

After lunch the various crews turned out for the transmitter hunt. The various arrays that were hung, pushed up or tied on the various cars attracted much attention, perhaps the most novel arrangement was Harold, VK2AHA, perched on the front of a Renault complete with antenna, receiver and power supply. The Renault was specially selected as the hot end is at the back.

TRANSMITTER HUNT

Two transmitters were in operation at the hidden location, one on 144 mc/s, supplied and operated by John Miller, VK2ANF, and the other on 3.5 mc/s, provided and operated by Jim Cowan, VK2ZC. They were operated simultaneously. 19 teams started off in the search.

State secretary Dave Duff, VK2EO, was official starter and after concluding his duties, stepped aboard and won the search and the cup. Using 3.5 mc/s, Dave won in the record time of 14 minutes and upset the calculations of the UHF gang.

They, however, were close behind Wal Nye, VK2XU, and Harold Whyte, VK2AHA, both using 144 mc/s tied for second place in 14½ minutes and Alick Dan, VK2ABU, also using 144 mc/s, was third in 15 minutes. As you will see from the times quoted, it rather developed into a 100yd dash at the finish.

After the departure of the parties, Heather and Ted Davies, VK2FE, assistant treasurer and treasurer of the division, provided entertainment for the kiddies and ladies.

The Woy Woy Scramble ran for half an hour and competitors were allowed to use any power and any band. The winner was the amateur who could contact the greatest number of stations in the period. Jim Cowan, VK2ZC, contacted 18 stations in the half-hour, including a VK3, and won the trophy.

In second place was Jim Georgeson, VK2AKU, with 17 contacts, and third, Wal Nye, VK2XU, 16 contacts. The number of stations worked in every case was certainly impressive and the co-operation of country amateurs who stood by to give competitors plenty of contacts was much appreciated.

The official portion of the program in the afternoon was conducted by State president John Moyle VK2JU, who announced the winners of the various competitions and thanked the many helpers for their services.

The presentation of prizes was made by Lionel Swain, VK2CS, president of the Hunter branch. Prizes were donated by the NSW Division, except a special prize presented by Ern Ashley, VK2ASE, for the youngest baby present.

The usual bran-dip was conducted late in the afternoon. 13 special prizes were included, ranging from command transmitters to heavy-duty genemotors.

Of the many highlights, first must be recorded the work and organisation of local members who made the day possible. Cess, VK2KR, and his wife worked extremely hard for the success of the day, while John, VK2GA, supplied all the answers to the requests for supplies of all kinds.

A new feature for the day was a "Swap Table," conducted by Major Collett, VK2RU. It proved very popular and over £70 worth of equipment changed hands. Jack Francis, VK2OF, did his usual good job in the kitchen, but took enough time off to win two prizes in the amateur quiz and frequency guessing competitions.

From the North Coast Zone officer Noel Hanson, VK2AHH, and Len Turner, VK2LR, did a round trip of 650 miles to attend. Bob Wilson, VK2AFS, and Dave Evans, VK2AYE, supplied the heavier refreshments, while the latter and Harry Powell, VK2AYP, performed the rather arduous task of dispensing it. Of the many helpers were VK2ZQ, VK2AAN and VK2XU, who arranged the bran-dip, plus 2VL and others.

Each year the event becomes more popular and the council appreciates the support afforded the field day by members.

NATIONAL FIELD DAY

ALTHOUGH in the past support for this event has been limited it would appear that during the past year many amateurs have installed mobile equipment, and this should help to swell the numbers of competitors.

A summary of the rules is as follows:

The contest will be held between 0900 hrs EAST and 2100 hrs EAST on Sunday, January 27.

The contest is limited to portable stations operating within the Commonwealth and its mandated territories, and power input not in excess of 25 watts.

The station must not be located within five miles of the home location, must not obtain power from either private or public mains, and not located in any occupied dwelling.

Equipment cannot be set up earlier than 24 hours prior to the commencement of the contest and more than one operator can be used.

More than one transmitter can be used, but one only at any one time.

Call CQ/FD on CW and CQ Field Day on telephony.

The contest is divided into three sections: Open, CW and phone, and a separate log must be entered for each section.

Logs, giving full details of operators and equipment, plus location, &c., must reach the Federal contest committee, Box 1734, GPO, Sydney, by February 27, 1952.

The following areas constitute VK districts for the purpose of the contest. VK2, VK3, VK4, VK5 (SA); VK5 (Northern Territory); VK6, VK7 and VK9.

Serial numbers must be exchanged — signal reports plus any number between 001 and 100 for the first contact and progressing by one for each successive contact.

The scoring is as follows:

With fixed station in same State, one point; portable station in same State, two; station in Asia, North America and Oceania (not VK), 3; Europe, 5; Africa and South America, 7; portable stations outside the competitor's State, 10. A bonus for each continent worked on each band, 25 points. Bonus for each State or country worked on 50 Mc/s, 25 points. A special bonus for each interstate or overseas contact on 144 Mc/s, 50 points.

Attractive certificates will be awarded to the outright winners in all sections. They will also be awarded to each operator of the winning stations provided each operator has contacted 25 pc of the stations worked. An order for three guineas will be awarded to the three outright winners for the purchase of a trophy or equipment.

In limiting the operating times to one day only the contest should attract more entrants who can proceed into the field for one day only.

JUBILEE RELAY

THE jubilee relay contest was won by Stan Coleston, VK9XK, who, using three different bands, contacted 343 in 80 countries for a total of 27,440 points. A very fine performance and with the other competitors did much to ensure the success of the jubilee VK/ZL DX contest.

In second place, not far behind the winner, was Keith Schleicher, VK4KS, with 26,480 points. Working 331 stations in 80 countries using two bands; and third was Tom Stroud, VK2AMR, 275 stations in 78 countries.

Some 3300 messages concerning Australia's jubilee were sent to approximately 100 countries during the contest, and the Federal contest committee was extremely gratified with the support afforded the relay.

ANNUAL HAMFEST

THE NSW division's annual hamfest will be held on the Australia Day weekend, January 25, 26, 27.

The normal monthly meeting will be held on the Friday evening and a special lecture and demonstration is to be arranged. Final details of the program for the weekend are not available at the time of writing but will be fully publicised over VK2WI. The tentative program for Saturday and Sunday is as follows:

The Saturday afternoon and evening entertainment will be held at Federation House, Phillip St., Sydney.

From 2 to 5 pm a series of lecturettes and demonstrations of amateur equipment will be presented and during the evening the division's annual dinner will be held in the Sky Ballroom. Those that remember last year's successful functions will be certain to attend.

The Sunday program will be limited, to allow members to join in the national field day, and it is hoped that many parties will participate.

Listen to VK2WI at 1100 hrs Sunday for final details.

SILENT KEY

IT is with deep regret we record the passing on November 25 of one of the oldest active amateurs, Rev. W. Kennedy, VK2WK, of Helensburg, aged 82 years.

Born on November 23, 1869, in Pitt St., Sydney, he entered the PMG's Department and later studied for the ministry. In the early part of the century he was actively engaged in wireless experiments and co-operated with Father Shaw, one of the first broadcasters. It was not until 1925 that he obtained his AOCP, and held certificate No. 127. He operated from many suburbs of Sydney and later from Helensburg.

Bill, as he was well known to amateurs, was very active until three years ago and leaves a gap in the ranks of old-timers.

THE UHF's

NOVEMBER and early December saw the 50Mc band really open for the summer season, but main emphasis was on the 144 Mc band and some interesting contacts were recorded.

TELEPHONE

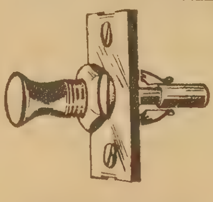
These Don 5 telephones are suitable for the office, farm or factory. Each phone is equipped with new Batteries, hand set and buzzer. All are in good working order. Easily installed, simple to operate.

OUR PRICE 55/-.

BRITISH NAVY TELEPHONES

This telephone was built specially for the Navy. It is very solidly constructed, in metal case, finished in battleship grey. A hand generator is provided, and no batteries are required to operate the phones, as dynamic inserts are used in both receiver and transmitter.

Excellent value at 5 guineas each.



SWITCHES

Special Line of Semi Rotary

Switches suitable for voltages up to 240 volts ideal for switching any type of radio, etc., has ¼" shaft to suit standard size radio knobs. Single hole mounting, easily worth 4/6.

Our Price, 1/9 each.

We have just landed a quantity of push-pull S.P. switches as illustrated. These are single hole mounting.
Easily worth 3/6.
Our price 1/3.

Single Pole

TOGGLE SWITCH

In solid bakelite with nickel-plated toggle for low voltage work (up to 32 volts) very robustly constructed. Easily worth 3/6.

Our Price, 1/9 each.

Dual Ignition Switches

As used in aircraft. A good pair of switches for heavy duty low voltage work (up to 32 volts) worth 7/6.

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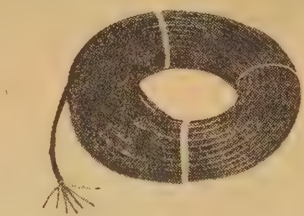


CABLE

5 Core Cable, each core a different color and rubber covered. Complete cable is enclosed in black celluloid covering. Ideal for battery cables, speaker extensions, etc.

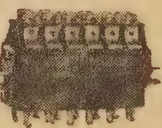
Price, 1/3 yard

WIRE

Outdoor Aerial Wire. 7 strands of steel, one of copper, insulated and weatherproof. 100ft lengths, 5/- each. Special price for large quantities.

Twin Shielded Wire. Suitable for Radio work. Two rubber insulated stranded cores of different colors, enclosed in woven tinned copper sheath.

Price, 1/3 yard

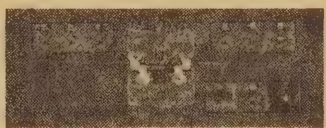


JONES

Plugs and Sockets

As illustrated. Available in following sizes, all brand new and in perfect condition.

6-pin, 5/6 8-pin, 5/6 12-pin, 8/6



SWITCH PANEL

Consists of two triple toggle Switches and 3 Single Toggle Switches all in solid bakelite case with N.P. toggles. Also four push-button switches made of bakelite. All switches are suitable for voltages up to 32 D.C. and with handle up to 20 amps.

Price of complete panel, 10/6

MORSE KEYS

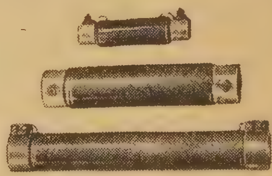
Army type. A lightweight key for portable equipment. Easily worth 25/-.

Our Price, 2/11

CONDENSERS

We have limited stocks of the following Paper Tubular Metal Cased Chanex Condensers, available in the under-mentioned types.

Cap	Wkg. Volts	Price
.5 mfd	200v.	1/3 ea.
.5 mfd.	400v.	1/6 ea.
.1 mfd.	400v.	1/- ea.
.35 mfd	400v.	1/- ea.
.25mfd.	400v.	1/- ea.
.02 mfd.	600v.	9d. ea.
.01 mfd.	600v.	7d. ea.
.006 mfd.	600v.	7d. ea.
.0025 mfd.	2000v.	1/3 ea.
.001 mfd.	600v.	7d. ea.



British Navy Resistors

Resistance	Wattage	Price
25	20	2/6 ea.
250	20	2/6 ea.
350	25	2/6 ea.
500	27	2/6 ea.
500	55	4/- ea.
1000	25	2/6 ea.
1000	85	5/- ea.
1000	120	5/- ea.
1500	25	2/6 ea.
2000	20	2/6 ea.
2000	25	2/6 ea.
2500	85	5/- ea.
4000	20	2/6 ea.
5000	55	4/- ea.
5000	20	2/6 ea.
7000 Tapped at 3000	55	4/- ea.
10,000	10	2/6 ea.
10,000	55	4/- ea.
12,500	20	2/6 ea.
15,000	20	2/6 ea.

Notice!

All parcels sent registered post unless otherwise stated. Postage or freight must be included with order.

M/S MOTOR SPARES LTD. 547 ELIZ. ST., MELBOURNE.

VK2PN and VK3UI recorded a fine contact on 144 for a distance of 200 miles. The former was operating from the mountains outside Tumut, while VK3UI was at Mt. Major, in the Granites.

In late November Hugh Stitt, VK2WH, believes he heard either ZL1JZ or ZL2JZ on 144 Mc/s at 1910 hrs EAST on November 20. He awaits confirmation or otherwise. Arch Cox, VK2GU, of Canberra, using a 12-element array and 100 watts, has contacted VK2ANF and VK2MQ in Sydney on 144, while Allan Thackeray, VK2TA, Young, using 32 elements, puts an excellent signal into VK2WH at Forbes, a distance of 75 miles. VK2ANU, of Muswellbrook, has also been contacting Sydney on 14 Mc/s. It seems certain that with higher power and multi-element arrays someone this summer is certain to record a contact over 500 miles, perhaps one between the capital cities.

VK9XK operating on 50 Mc/s in the last week in November contacted VK4BT for his first Australian contact; a few days later he worked VK3UI and VK2WH.

He uses an 807 with 20 watts to a three-element beam on 50.02 Mc/s.

During an excellent opening on December 1 VK2UC reported hearing KH6s. All States and New Zealand appeared besides quite a few stations around the 300-400 mile range.

The NSW division's UHF section 144 Mc/s mobile contest resulted in a win for John Miller, VK2ANF, with 55 contacts and in second place was John Meagher, VK2AMV, with 46 contacts. The latter is a country amateur and recorded most of his contacts after a 400-mile round trip to the Blue Mountains.

The section has arranged an attractive program for the UHF gang for 1952, the first event is a 144 Mc/s contest to be run nightly from 1900 to 2300 hrs on January 18, 19 and 20. Full rules will be broadcast over VK2WI.

WIA NEWS

THE November meeting of the NSW division was mainly devoted to the originating of agenda items for the 1952 Federal convention. During the evening, however, Wing-Commander C. Beurle, of the RAAF, explained the workings of the RAAF Active Reserve and the terms of service. He mentioned the reasons for not re-forming the RAAF Wireless Reserve postwar and this was mainly due to the fact that all the point-to-point services were now practically automatically operated and the demand for operators was limited. Visitors to the meeting included G3GVN, VK9RC and VK3IE.

After a considerable amount of discussion the meeting passed a motion that fees be raised to £2/2/- for full members and £1/5/- for associates. In view of the rising costs and to ensure the re-introducton of monthly bulletin, the motion was extremely well supported.

A considerable number of agenda items were sponsored.

A.O.C.P. CLASS

The Victorian Division A.O.C.P. Class will commence on Thursday, 17th January, 1952. Lectures are held on Monday and Thursday evenings from 8 to 10 pm. Persons desirous of being enrolled should communicate with the Secretary, W.I.A., Victoria Division, 191 Queen Street, Melbourne (Phone FJ6997, from 10 a.m. to 4 p.m.), or the Class Manager on either of the above evenings.

YOUR OPPORTUNITY

to join the world-wide ranks of amateur transmitters! The Wireless Institute of Australia holds regular classes in Sydney to assist Sydney and suburban enthusiasts to obtain their Amateur Operators Certificates of Proficiency.

Write for particulars to the Class Manager, W.I.A., Box 1734, G.P.O., Sydney.

FOR PERSONAL SHOPPING

We have branches at 319-321 Swanston St., and 393 Flinders St., Melbourne, C.1.

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AUSTRALIA'S LEADING DISPOSAL STORES

MAIL ORDER CUSTOMERS

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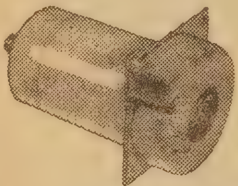
HOME LIGHTING SPECIAL

Battery Charging Generators.

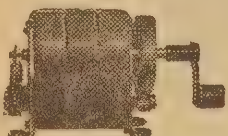
Suitable for use on 32 volt systems without alterations.
24 volt 1500 watt £15/15/-
24 volt 1000 watt £12/15/-
We can also supply a suitable 3½in V-PULLEY 35/-, & 50-0-50 Ferranti amp meter 50/-. Freight forward rail.

Blower Motors



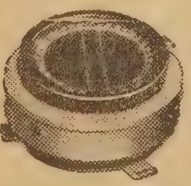
24 volt A.C. D.C. Ideal for small ventilating jobs. Price **39/6**
Postage: Vic. 2/3; Interstate 4/6.

BELL RINGING GENERATORS



A small neat A.C. Generator complete with handle and 3 screw fixing base. Change over shaft actuated contacts for telephone ringing, shocking etc., suitable for converting Don. V. phone to bell call . . . **37/6**
Post: Vic, 3/-; Interstate, 4/9.

Compass Type P4



7in diam. x 3½in. deep, liquid filled, spring mounted. Navigational Compass. Reconditioned as new. Price **£4/10/-**
Postage: Vic, 3/9; Inter., 7/6.

DASHBOARD CLOCKS

An 8-day clock made by the "Waltham Watch Co." Precision built with a 17-jewel movement and 24-hour dial, plus these special features:—

DISPOSALS £9.10 PRICE

TELLS DATE: With plunger type date setter for short months.
CLEAR BOLD FACE: Each day, hour, min., & sec. Clearly indicated.
SWEEP SECOND HAND: For really accurate timing over a distance.
NEAT SIZE: 3 1/8in will not mar the appearance of your dashboard.
Postage & Packing: Vic, 2/9; Interstate 4/- (reg.).

MAKE YOUR OWN FISHING ROD

FROM A TANK WHIP AERIAL: Two 4ft tapered sections of tubular spring steel, by the simple addition of a butt and runers, you'll have a rod fit for a champion.
DISPOSALS PRICE **15/-**
Freight forward rail.

SPOTLIGHT SPECIAL

R.A.F. SIGNALLING LAMPS

Ideal for night shooting, 5" reflector, twin handle grips and trigger switch, both 12 and 24 volt available. All in "A1" condition.
DISPOSALS PRICE . **30/-**
Postage and Packing, Vic., 5/-; Interstate, 7/6.

POWER SUPPLIES

No. 11 POWER PACKS. 11 volt 2.5 amp input; 210 volt .05 amp output. Complete with filters. AN IDEAL POWER SUPPLY FOR CAR RADIOS.
DISPOSALS PRICE **35/-**
Freight forward rail.

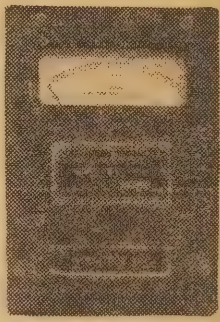
Build Your Own Dumpy Level

With the "ASTRO COMPASS," a precision built instrument, originally used for finding the direction and bearing of an aircraft, this instrument can be made (with slight modification) into an accurate dumpy level. Containing declination scale with micrometer adjustment, azimuth circle, 2 cross levels and adjustable turntable mountings. IDEAL FOR THE HOME BUILDER.

Disposals Price . . . 59/6

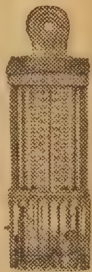
Post & Packing: Vic., 3/9; NSW, S. Aust, 6/-; Qld., WA, 8/6.

Bonding Testers



Low Resistance Measuring Sets, calibrated scale 0-0.1 ohm. Made by Evershed. Brand new.
Price **35/-**
Postage: Vic, 3/-; I'state, 5/-.

Hygrometer



A wet and dry thermometer for temperature and humidity reading. As supplied to the R.A.A.F. Every dairy farm should have one. Complete with chart, **19/6**
Postage: Vic, 2/3; I'state, 4/6.

PRISMATIC ELBOW TELESCOPE

American make, with approx. X8 magnification, extra wide field and COMPLETE WITH COLOR FILTERS
Disposals Price **£5**

A limited number of English elbow telescopes, approx. X6 magnification, normal field.
TO CLEAR **65/-**
Postage & Packing: Vic, 3/9; NSW, SA. 6/-; Qld, WA, 8/6.

MORSE KEYS

PRICE, Complete WITH BUZZER . . **7/-**
Postage and Packing: Vic, 2/-; Interstate, 3/6.

SUITABLE NEGATIVES TO ENLARGE

(Continued from Page 89)

simply to get a few snapshots of his friends on a picnic he may as well give the game away, or at least revert to cheap camera from which only moderate results are expected anyway.

All of which boils down to the question, "Can I manage without a tripod or not?"

In many cases I think you can and, in fact, that you should learn to, for there are occasions when it is a case of a camera only or nothing.

What, then, can be done?

First, always take advantage of any natural support which may be available, such as chairs or tables, the mudguard of a car (with something to protect the surface), the side of a tree or building, a railing, a fence post, or indeed anything at all which you can press into service. With a little practice you will be surprised how often you can find something suitable, the main idea being to get into the habit of looking for it.

It may be possible to make or buy a simple pocket type device which provides many of the advantages of a tripod without its bulk or weight. This is simply some form of clamp or clip fitted with a standard tripod screw to suit the camera bushing. In use it may be attached to any convenient object and will often provide a more rigid support than is obtained by simply resting the camera on an irregular surface. The point to watch with such devices, and with tripods too for that matter, is that they are truly firm, otherwise they may be worse than nothing.

HOLDING THE CAMERA

When none of these forms of support are available and the camera must be held, pay attention to the following points: Use the highest possible shutter speed. Make your body provide as much support as possible, the exact manner depending upon the type of viewfinder. Where an eye level finder is available it would appear that better support is provided by pressing the camera against the face than is afforded by the chest.

Make sure that the shutter release is as smooth as possible and, when using an eye level finder, it is essential that this be either a cable or built-in body type. The latter is usually more convenient but, unfortunately, seldom works as smoothly as a cable. In any case practice releasing the shutter with a steady pressure rather than with a sudden jerk. If you are not happy with the result of such practice it may be worthwhile having the mechanism checked for any binding or lack of alignment which may prevent smooth operation.

Finally don't lose sight of the fact that there are many occasions when you can carry a tripod without any great inconvenience (as for example when travelling by car) and in such cases it is a very useful device to have handy. It may well be that you will be presented with scenes just asking to be recorded, but which are not likely to be available for a second try. In a case like this what objection can there be to taking a little extra time to set up a tripod and make sure of your picture?

Again there is the poor light situation which can only be overcome by using a long exposure. While it may be possible to keep your model still for one or two seconds, and the landscape certaintly won't move, it is impossible to hold the camera for this length of time. In these circumstances it is a case of some kind of support, such as the tripod, or no picture. Seems a pity to miss out doesn't it?

LEARN WHILE YOU BUILD

(Continued from Page 67)

10 milliamps through the circuit but of this only one milliamp flows through the high resistance of the meter and series resistor and nine milliamps flow through the 166.6 ohm resistor. Thus the meter reads full scale when the test terminals are short circuited.

If we were to place a 150 ohm resistor between the test terminals it would double the total resistance of the circuit and allow 5 milliamps to flow. Of this, .5 would flow through the meter causing it to read half scale. This condition is in contrast to that which would occur when a 150-ohm resistor was tested with the original circuit (figure 1c) when it would only alter the total resistance, and hence the meter reading, by about 10 pc.

LOWER RANGE

Carrying this idea still further we can provide a resistor which will reduce the total resistance to one hundredth of its original value and give an even lower range. The value required in this case is 14.8 ohms. When this is brougth into circuit the current flow will be 100 milliamps and a 15-ohm resistor will cause the meter to read half scale.

If you examine the scale of the meter you will see that the lowest division on the ohms scale represents only .25 ohm. This means that the total resistance measuring capacity of the four ranges provided by this circuit covers from .25 ohm to 1,000,000 ohms. This is quite a considerable range and will cover almost all the requirements of radio testing. There may be few occasions on which you will encounter values higher than one megohm, although these are rare, but in any case values up to 10 megohms will still cause a readily discernible movement of the pointer.

At the other end of the scale the ability to read very low values of resistance is extremely useful since it enables accurate measurements to be made of such things as coil resistance, contact resistance, and even the resistance set up by a "dry" soldered joint.

By now you can probably see the wisdom of calibrating the ohms scale with figures representing the lowest range normally provided. Not only does it avoid crowding the scale, but it also means that it is only necessary to multiply these figures by 10, 100 or 1000 (by adding one, two, or three noughts) for the three higher ranges. Division of the scale values, which is not always quite so convenient, is thus avoided.

The overall accuracy of an ohmmeter, while not equal to that of specialised laboratory instruments, is quite sufficient for radio work where it is unusual to require resistors to have a greater accuracy than 10 pc. The highest accuracy occurs at or near the centre of the scale and, wherever possible, a range should be selected which gives a reading in this region.

It is almost inevitable that as soon as this article hits the news stands someone will put pen to paper to query the accuracy of the 166.6 and 14.8 ohm resistors. Yes, you're quite right. No matter which way you work it out, these values neither reduce the total resistance to the figures which have been quoted, or represent true shunts having the factors claimed. Where, then, is the "catch?"

The "catch" is the battery, or, more correctly, its internal resistance, a characteristic which is very often overlooked in calculations of this kind. The effect of the internal resistance is very much as if the battery had similar value of resistance connected in series with it, and results in a reduction of voltage with increased current drain.

BATTERY RESISTANCE

In our fundamental circuit (figure 1c), the current drain is only one milliamp, but for the two lower ranges it is 10 milliamps and 100 milliamps respectively. If the battery had negligible internal resistance, the voltage would remain constant for all these conditions and the two resistors would need to be 15.15 and 170 ohms, the values which result from the application of normal shunt calculating techniques.

If the battery were large enough it might be possible to approach these conditions, but it would seriously affect the portability of the instrument. To keep size and weight down to a reasonable figure, a small torch cell, such as the type 950, is normally used and its internal resistance is high enough to cause considerable error when used with these calculated values. This applies particularly to the lowest range. Hence the slightly lower values which permit the use of a small cell while retaining normal accuracy.

So much, then, for the "Learn." Next month we will describe how this circuit can be built around standard components to form the first part of your multimeter.

GLYCERINE ON HANDS

OFFICE workers or others who handle large quantities of papers or currency will find that a small amount of glycerine rubbed on the hands will make their job easier. The glycerine provides friction between the fingers and the papers, making the use of cumbersome rubber "fingers" or other mechanical devices unnecessary. A light application of glycerine will last for several hours and is not harmful to the skin. It can be obtained at any chemist-shop.

OFF THE RECORD — NEWS & REVIEWS

A subject which has been raised in the mail more than once during the last few months is that of home recording. Several readers have wanted to know how I have been getting on with disc recording, and whether I have any new ideas on tape, and of tape versus disc.

By JOHN MOYLE

IN reply, I would say that my disc recorder has been in constant use now for over 12 months, and that it has given me more pleasure than almost any other device I have made up, certainly in the realm of recorded music.

When first tackling the problem of making micro-groove records in the home, I had grave misgivings. It seemed a little too much to expect the fine accuracy required in cutting the closely spaced track to be maintained, even if initially achieved.

My comments refer to micro-groove because I rarely cut now with standard grooves and 78 speed.

There are several reasons for this. In the first place, the 78 speed runs through discs far too quickly. On the few occasions when I have had cause to use it, I have been appalled at the rate at which the uncut record disappeared.

With microgroove, the slow record speed and gradual progress of the stylus across the disc almost removes the sense of mechanical urgency from the process, leaving more time to deal with the urgencies arising out of what is being recorded. And they can be plenty when things are happening fast!

Discs these days cost money, and five minutes per side isn't enough return to make the game too popular, particularly when one has experienced a system which gives four times that amount.

Apart from the cost, there is the advantage of long playing which has been stressed often enough in these columns to need no repeat.

I am quite satisfied that there are no more difficulties in cutting micro-groove with good equipment than with the faster speed. In some ways it is much easier. We all experience trouble with the swarf from time to time, most particularly at the start of the disc. For once a cut is cleanly commenced, the risk of tangling isn't nearly as great.

NOT TRAGIC

With microgroove, it isn't a tragedy as far as the disc is concerned if you make a bad start. It's true that the commencement of the item is ruined, and one will have to start again, if he can, but a few useless grooves cut with the close spacing usually isn't at all embarrassing, and the disc is almost as good as new.

But with 78 rpm, I usually find that enough of those precious five minutes (for a 12in disc) has run out to spoil the disc altogether except for a shorter run. And to tell the truth, I have had more trouble with the swarf on 78 than I have had with micro-groove.

However, given a well ground sapphire, it is only on odd occasions I have had this trouble at all. If I feel like it, I generally blow gently across the disc as I lower the cutting head, just to give the swarf a clean start towards the centre of the record. After that I am hard put to it to remember when a tangle took place before the side was finished. Incidentally I use the inside start to make it easier.

GROUPING

The most obvious danger with microgroove cutting is from grouping—uneven spacing of the grooves due to badly cut or worn gears. About this I can only say that, with the two recorders upon which I have worked, this grouping can only be seen in a cross light and has no noticeable effect on recording. This speaks much for the quality of the manufacturer. On the one or two occasions when grouping has become more pronounced, a thorough cleaning and lubricating of the gears to ensure absolutely free and smooth-running has brought things back to normal.

Wear on the cutter, too, I have found surprisingly low. I've used the present stylus for many months, and it still cuts well. To maintain a highest standard no doubt more frequent regrinding would be in order, but I'm sure the average man would get a year's service with a reasonable number of discs.

Concerning surface noise, the quietest discs I have cut have been at the 78 speed. With everything

just right, and plenty of modulation, my best 78 records have absolutely no background at all from the discs themselves. The best microgrooves are just about their equal, but on the whole, surface noise is somewhat more noticeable than with the 78's. I have found 45 rpm the best compromise in the matter of noise v. playing time.

Unfortunately, there are variables here for which I can't altogether account. The worst cases have a smooth hiss far below the normal shellac pressing, but still heard on quiet passages. The best cases, and sometimes cut on the same night with discs from the same box, have such a low surface noise as to be virtually inaudible. I suppose variations in discs could account for this, but it seems to be a problem that has always faced recordists, both amateur and professional, and which is hard to assess usefully without a good deal of trouble and equipment.

OTHER RESULTS

Despite these things, and because I have been able to record items which I want to hear for themselves, I have received an enormous amount of pleasure from the recorder. If it isn't as wide in range as a professional type, it is as good as the radio programmes themselves when heard through the receiver, and better than any but the latest examples of professional recording.

Can the average man repeat my results? Well, I heard a week or two ago a record made by a man who duplicated the recorder, and who, I believe, had never built a set before. In appearance and in quality, I'd say his record was just as good as those I have made myself.

The records I have found to wear extremely well. No record I have made—and some of them have had plenty of playing—has shown any noticeable signs of wear. I use the Acos pick-up for testing finished records through the recording amplifier, and the rebuilt HMV pick-up for future playings, although I have used other pick-ups as well from time to time. I've always kept the stylus point weight as low as I could, and, of course, used good sapphire points.

TAPE

I think that answers most of the points I have been asked from time to time. Now as to the tape, I don't think anything has happened lately to change my opinion that tape and discs are two different and non-competitive methods of recording.

Tape is just fine for playing about, making records which aren't required permanently, for special purposes where wiping out and starting again is a "must," and so on.

Not the least attractive thing about tape is that a few spots of excessively high level won't matter very much, whereas they can completely ruin a disc, either by introducing an unpleasant raspberry, or by cutting grooves which can't be played. Tape is easier to handle that way.

But I think any tape man will agree with me, either amateur or professional, that really high quality tape recordings aren't easy to make.

The average recorder available for about £120, plus or minus, suffers from limitations, which don't go kindly with recording music on a par with good discs.

SINGLE MOTORS

Most of these recorders use a single motor to keep the cost down. Many of these are most ingenious in the design of clutches and the like, but they nearly all have just enough unsteadiness or "wow" to spoil that type of music—piano for instance—where any wow at all can't be tolerated.

In the interests of economy, they generally run at 7½in per second, and at that speed its hard to do better than about 6kc, without serious drop in response. Some may dispute that statement, quoting ideal figures to support their protests. But I know at least two men in the game who will agree with me. To make a 7½-inch recorder which really holds up at both ends isn't easy. Anything better than this calls for quite a lot of money.

I'm not saying that the results don't sound quite good, of course. I am merely saying that all I have heard do not produce results as good as those I can get without trouble from the disc recorder at the present time.

Moreover, the snag with the tape is in the matter of storage. Good tape costs plenty of money. If we run it at 15in per second, results are enormously improved and can be fine. But we need more tape than the average man can face up to, and certainly more than he can afford to keep in a library. I must have at least 50 discs, I think, are good enough to keep permanently. I'd hate to fork out for that amount of tape!

STORAGE

The disc is particularly convenient for storage. Its enemy, of course, are dust and fingermarks. Unless kept scrupulously clean, and preferably in a layer of tissue and an envelope, dust and scratches are bound to show up in time. Tape doesn't need such care although it has a few troubles of its own.

I think we'll probably hear more of the tape method before we are done, however. It has some most attractive features. But I think it unwise to consider it a competitor of the disc. You'll choose a recording medium depending on your use for it.

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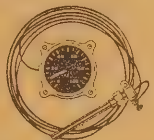

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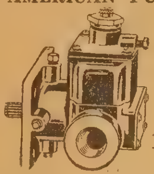

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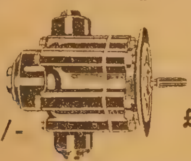

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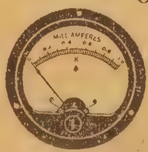

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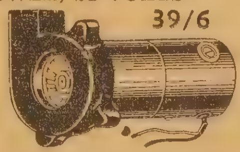

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SERVICEMAN WHO TELLS

(Continued from Page 39)

the frequency of the offending station I was able to improve things somewhat. However, it still overlapped adjoining stations and I advised the owner that such separation was quite beyond the scope of the set, that it had long since outlived its usefulness, and that the only real solution was a new set.

I gathered that this idea was not very well received, the owner not being too keen on the financial outlay, "what with the high price of sets an' all," and I was asked could I make the set a bit stronger.

It certainly was rather weak and the reproduction was very high-pitched, giving the impression that the electrolytics had failed. (Oh, yes, it used electrolytics, but they must have been the first ones ever made!) There was no hum to support this theory, at least no more than was normal for a set of this type, and I decided that the chassis had better come out for closer examination.

As I was fumbling under the shelf trying to unscrew a chassis bolt, I noticed what appeared to be a piece of newspaper protruding from behind part of the speaker housing. Closer examination proved I was correct—it was a piece of newspaper, just about the full double page, folded into a tight wad and wedged betweed the cone and the speaker housing. Not only that, there were three more, one behind each of the "spokes" of the speaker housing, and the net effect was to force the cone outwards to the limit of its suspension system.

HUM REMOVER

As soon as I removed them I knew why they had been put there. The hum was terrific, and I realised that both the electrolytics must have "had it" a long time ago.

When I inquired as to how they got there, I was informed that "Bill" (presumably the son of the house, although I didn't press the point), had "done something to the speaker when it started to rattle like that." (Indicating the rich raspberry sound it was now giving forth.) "It fixed it, too," he added, with an air of pride, "but the stations weren't very strong afterwards."

It wasn't hard to imagine what had happened. The hum had been getting progressively worse, until someone, probably "Bill," just couldn't stand it any longer. Then the bright lad had set out to find where it was coming from. Being such a bright lad, he found it was coming from the speaker, and in particular from the paper cone, which was vibrating back and forth. Now all he had to do was prevent it from vibrating, which he did most effectively with the wads of newspaper.

What a pity someone hadn't told him that the cone was meant to vibrate in order to reproduce the sound of his favorite crooner or race commentator.

Naturally, I replaced the electros, trying my best to keep a straight face the while, and with the performance much improved, at least in some respects, I left them to enjoy the doubtful pleasure of listening to two stations at the one time.

Ah, well, it's little things like that which make life worthwhile!

ANSWERS TO CORRESPONDENTS

A. B. (Toorak, Vic) forwards 12 months subscription and makes some comments about the articles in Radio and Hobbies.

A. Thanks for your subscription A. B., which has been forwarded to the appropriate department. If you have in mind to use the Junior recorder for tape recording we would point out that tape recording requires a frequency characteristic which is not normally available in equipment designed solely for disc work and, for this reason, results from the Junior recorder are likely to be disappointing. While we would all like to design a portable with only 4 mA HT drain the fact must be faced that such battery economy could only result in extremely poor performance, mainly in the matter of power output. We would imagine that such a circuit would be intended for earphone reception rather than to operate a loudspeaker for the amount would be extremely small. We hope to go into the matter of transformer impedances in the near future, possibly in the Answer Tom section.

L. W. (Long Jetty, NSW) sends two problems for the Answer Tom page.

A.: Many thanks L. W. and we have filed these for possible future use. In the meantime we can say that in the first problem, that of the transformer, your assumption is correct and that of your friends is incorrect. The impedance figures quoted for a transformer do not apply to the individual windings but refer to the ratio between them. Thus the figure quoted for either the primary or secondary has no meaning by itself, but only when the other is known. Normally the impedance of either winding, when the other is unloaded, is very much higher than these figures and the assumption of two impedances in parallel is incorrect. The two AVC circuits do not appear to differ very greatly and while the time delay may not be exactly the same the difference would not be of any importance in practice. It is possible that the second one would provide rather better de-coupling but again the first would probably be adequate.

H. W. (Abbotsford) queries the accuracy of a statement in our November issue and forwards circuit current in 1925 to substantiate his argument.

A.: Many thanks for letter H. W. and for the trouble you have taken to copy the circuit you enclose. We assume you are referring to the picture and caption on page 11, in which case it is necessary to realise that the crystals in this receiver are being used in a manner quite different from that normally associated with crystals. In this case the crystals are actually the amplifying devices, no valves, in the accepted sense, being used. Thus you will find reference in the caption to a crystal valve together with some of its characteristics. It is, therefore, quite correct to say that this is the first time that a crystal has been associated with the ability to amplify as well as the more common function of detection. It is likely that we will hear a lot in the future about the use of these devices in specialised units, particularly where space, weight, and rough handling are likely to create problems on the use of conventional valves.

D. H. C. (North Hobart, Tasmania) is studying for his AOCP and is anxious to obtain a circuit of a VFO which can be made from parts normally available on the Australian market.

A.: The matter you suggest has not been overlooked, D.H.C., but so far we have not been able to do as much research work as we would like, this having to be fitted in between current projects. However, it is most important to realise that there is really no simple solution to the problem and the various devices which you mention are used only because they are essential for a satisfactory degree of stability. The special condensers required are normally available from local manufacturers, while it would seem unwise to dispense with regulated power supply, as voltage fluctuations are a major factor in causing drift.

G. E. (Croydon, NSW) wishes to obtain constructional details of a Wimshurst machine and would like to know if any readers can provide assembly instructions complete with dimensions. Our correspondent is willing to pay for any trouble entailed.

A.: Your request, G. E., is now in the hands of our readers. For the benefit of any readers who may be in a position to assist, the address is: Miss G. Ellis, 56 Holborrow St., Croydon, NSW.

M. H. W. (Gilgandra) wants to know the cost of building the Superhet Four featured in the December Radio and Hobbies.

A.: We regret we are not in a position to advise readers of the cost of parts or kits of parts. Quite apart from the present unstable prices, we just do not have the time to investigate the prices charged by various sections of the trade. We can only advise those requiring such quotations to contact the various trade organisations who advertise in Radio and Hobbies who, after all, are in a very much better position to know these things than we are.

D. A. (Newtown, NSW) is having trouble with a single speed motor he is endeavoring to use for microgroove records.

A.: We are afraid the results you describe are about all that could be expected in the circumstances. The governor on motors of this kind is intended to maintain a steady speed at the prescribed 78 rpm. It is not intended to reduce the speed by the amount you are attempting and, when this is done, most of the energy of the motor is wasted in the governor and there is insufficient to drive the turntable. The use of the lightweight pickup will not reduce the load to the point where the motor will perform correctly and, incidently, this is not the purpose of the reduced weight. The lower value is chosen to prevent damage to the record which would result if normal weights were used with the reduced stylus point. The only real solution to the problem is the use of a motor designed for the reduced speed and achieving it by means of suitable reduction gearing.

J. L. McM. (Sale, Victoria) has been told that the dry type Leclanche cell can be recharged and wants to know if this is true and, if so, how it is achieved.

A.: Your reasoning regarding the chemical action of the dry cell is essentially correct and no reversal of this action is possible. However, a low value of reverse current through the battery can materially assist the function of depolarising, or the removal of hydrogen gas bubbles which is normally the job of the manganese dioxide. With this job carried out electrically the life of the manganese dioxide is prolonged and the life of the battery will be prolonged by approximately a like amount.

It is important that this so-called "charging" be conducted according to a well defined plan if the maximum benefit is to be obtained from it. First, it is important that the recharge be carried out after each discharge and little benefit would result from completely discharging the battery and then attempting to recharge it. It is also important that the charge current be kept low, otherwise the generation of heat and gas may do more harm than good.

The round type cells appear to be more suitable than the "Minimax" type, the later being prone to internal open circuits due to the formation of gas unless the rate is kept extremely low. Also the benefit obtained from these appears to be much less than that obtained from the round type.

Just how much benefit can be obtained from this process is a rather variable factor, depending on such factors as the rate and time of discharge, rate and time of charge, size and type of cell, etc., so that it is difficult to give precise figures. However, in the case of the round cells, it seems likely that an increase of 50 pc should be possible when all the conditions are favorable.

A.S. (Werribee, Vic.) is very anxious to obtain a receiver with good bandspreading on the short-waves. He mentions in particular the idea of divided gang sections and wonders why these are not used in Australia or even readily available.

A.: As far as the average Australian listener is concerned, the "dual-wave" feature in a set exists largely as a sales point and is very seldom used. It would be uneconomical and pointless for manufacturers to expend a lot of effort building elaborate facilities that would rarely be appreciated. Some manufacturers have turned out quite good bandspread sets, however, and these have found a sale amongst those who are more interested in overseas listening. We agree, however, that new Australians like yourself want the best you can get in the way of short-wave performance and the rising demand for sets of this type may make it worthwhile for some to turn out a special model. The best we can suggest, in the line of a home constructed set, is our "All-Wave De-Luxe" using an Aegis coil kit with two separate tuning condensers. This is more a communications type set than a domestic model however. Details of the circuit are available through the query service, if required.

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Readers say:

AMERICA v. BRITISH TELEVISION

The merits, or otherwise, of any television system must be based on facts. "Conclusions" are useless for the purpose of technical evaluation. I feel that many readers may be misled by Mr. Allan's letter in the November issue which condemns the choice of international standards (negative modulation and FM sound) for television in Australia. These standards were drawn up for sound reasons by experts. (See "T.V. The International Scene" in Electronics for August, 1950.)

The British system, positive modulation with AM sound, is used only in Britain and France and, of course, it is now too late to change to a more up-to-date system. The system is technically obsolete, particularly in respect of the AM sound channel, however painful this fact may be to its supporters.

There has been much agitation at various times for the adoption of the British system, but I feel sure that this is due to financial interests more than anything else, since the system has nothing to recommend it technically.

625 lines do give better definition than 405, but this is a mathematical, not a technical, fact, and applies to any system.

FM is far superior to AM. FM is far less prone to interference, it can often be heard satisfactorily through interference when AM is well-nigh blotted out.

Its service range is more reliable and is greater, the dynamic range and audio frequency range are greater, it simplifies receivers of the inter-carrier type, and can provide a source of voltage for AFC, holding the receiver precisely in tune regardless of oscillator drift for thermal or other reasons, and requires no extra tubes for this purpose, merely a few minor components. Can AM claim superiority on any of these points?

Microphonics with FM, AM, or anything else is a matter of good physical design as most radiomen well know, and may I also point out that deviation is not the criterion of quality, but is more closely linked with noise rejection.

Sync. separation is so simple it can be achieved by one diode for either system, even a crystal tube, not even requiring a heater! Where is the "involved circuitry"? The American systems use a form of sync. control (not separation) for the horizontal scan which, acting as a "flywheel," prevents tearing of the roster lines by interference pulses, so much objected to by Mr. Allan. "Tearing" is a fault not often seen in a good set properly installed.

The circuitry of such a "flywheel" or sync.-lock control is not necessarily involved either. It can be achieved using a double triode in place of the single triode usually used as a blocking oscillator—plus a few minor components.

Noise on the screen is black and less objectionable when present. Why go to the trouble of inverting an unwanted noise signal? Positive modulation is not immune to noise by any means, and "tearing" of the roster is not a question of "definition" but "interference."

The inter-carrier system is simple and, properly designed, very good. The sound system of an inter-carrier receiver need only consist of two tubes, no separate IF strip for sound being required as in the British system (see "Inter-carrier FM" in Electronics for April, 1950). This is economy indeed!

"Inter-carrier buzz" is caused by two main faults, overloading of the video stages—a matter of design or mishandling of contrast —and also by a transmission which allows the zero carrier level to represent peak white. Correction of the former is obvious, the latter cannot occur with the proposed system for Australia, since the minimum carrier level is 10 pc for peak white, and the carrier is never cut off.

This punches rather a neat hole in the theory advanced objecting to the use of inter-carrier receivers because of buzz. Rather annoying!

The inter-carrier receiver permits the use of an oscillator higher or lower in frequency than the signal since the difference in vision and sound is the same either way at 6 Mc. Tuning is less critical since all tuned circuits are broad-band, anyway, and, after all, AFC can still be used, if desired. Of course, one is not forced to use the inter-carrier system with our proposed standards. A separate sound strip may be used.

Sets using the international standards will be, using inter-carrier systems, &c., cheaper than any other built for other types of transmission. This is a point the public will favor. "Technicalities," to the public, count less than the costs.

Let us reject all proposals for using the obsolescent "Positive and AM" system, and take the superior international standard which Mr. Allan condemns. I can in conclusion only remark that his statement that he is, I quote, "a bit out of touch with current affairs re television," as surely being a masterpiece of understatement.

(K.G.W., Essendon, Vic.).

FURTHER TESTS ON PICKUPS

(Continued from Page 61)

compensating stage (as suggested for the "Playmaster" series), thence into a straight amplifier.

The curves in figure 2 show the output from the pickup as it would be AFTER full compensation for recording characteristics. The response from both heads is seen to be substantially level to 9 Kc. with a sharp peak from the microgroove head at just over 10 Kc. and at 16 Kc. for the 78 head.

The position of these peaks is perfectly typical for current magnetic pickups and emphasises the difficulty of pushing the treble resonance outside the audible limit for microgroove recordings.

Tracking qualities and waveform of the pickup were good, but the output from the two heads tested was lower than expected. The microgroove head delivered .03 volt across the load, while the 78 head produced .05 volt at 1000 cps. Peak output on music would be in the region of .15 to 0.2 volt.

BSR UNIT

Number 3 pickup was as fitted to the BSR record player unit. It has a magnetic head and the interchangeable styli are simply inserted as required. The leaflet suggests the stylus be pushed in as far as it will go, although our experience with this class of pickup is that, for microgroove at least, it is better to sacrifice some output and insert the stylus only partially, so that it has greater compliance.

The tests were conducted under precisely the same conditions as for the Decca pickup, and the curves in figure 3 show what the response would be AFTER compensation by an appropriate stage.

On microgroove, the response was substantially level to at least 7 Kc., and beyond that there appeared to be a resonance rise by about 2½ db at 10 Kc. The tracking was not perfect in this region, however, indicating the need for some adjustment to the counterweight or bearings.

No tracking difficulties were experienced on 78, however, the response being substantially level to 13 Kc, rising thereafter to a resonant peak at 16 Kc.

Output from this head at 10,000 cps was .04V on microgroove and .08V on 78 rpm. Peak output on music would, therefore, be in the .20 to .25 V. region.

LIBRARY paste will not dry in the brush used to spread it if the cap of an old fountain pen is attached to the paste jar with cellulose tape for use as a holder. Place a small piece of sponge in the bottom of the cap and, each time the paste is used, pour a few drops of water into the cap to keep the brush moist.

RECKLESS gondoliers in Venice are handed traffic tickets by police who roam the "streets" in small boats. The Venetian taxi driver now is confronted with traffic lights installed along the Grand Canal. More than 400,000 people travel by boat along 500 miles of canals in the city, and a huge increase in water traffic has forced the police to patrol the seaways

THE PLAYMASTER JUNIOR No. 3

(Continued from Page 83).

You would be wise to follow our parts placement in the interests of simple wiring and accessibility. Note the use of the terminal strips to mount the transformer primary leads, one end of plate, screen and decoupling resistors for the 6AU6, for the filter choke leads and filter condensers etc. Absence of a volume control means that the wiring runs straight through from input to output.

The output transformer we used has a separate feedback winding in addition to the voice coil, but for various reasons we did not use it. Just cut the leads short and tuck the ends out of the way.

It will be necessary to find by experiment the right side of the voice coil for feedback connection. The wrong side will provide positive feedback and uncontrollable oscillation. If this should occur, switch off immediately and wire the voice coil the other way round. The feedback resistor is mounted on vacant terminals of the speaker output socket.

The remainder of the components are quite standard types. It is a good thing to use 1-watt resistors throughout, although we have used some half- watt types. The larger resistors are no so likely to become noisy. Only the output bias resistor (3-watt) and the 2000 dropping resistor (5-watt) need be wire-wound types.

As the high tension voltage is not high, the filter condensers need have a rating no higher that 525 volts. For the remainder, 400 volts rating will do, except, of course, for the bias bypass condensers, which are 25 mfds, 40 volt types.

As indicated earlier, this amplifier is intended for use with either of the PLAYMASTER CONTROL UNITS although with a volume control added, it will work quite well directly from a crystal pickup. The control unit plugs in to the 6-pin socket.

IT is estimated that if all the dust in the atmosphere could be gathered together, it would make a cubical mass that would measure 587 feet on a side.

WANTED TO BUY, SELL OR EXCHANGE

FOR SALE: Brand New, perfect condition, with three films; 1 only 9.5 m.m. Projector, Movie. All electric, what a bargain. £25 post paid. Apply **P. Gatehouse, Milton.**

FOR SALE: R. & H. Multi Personal Portable. Good order with AC power pack and btys. £16/10/-. **M. Collins, 18 Natimuk Rd., Horsham, Vic.**

FOR SALE: 40 watt P.A. Amplifier. Tuner with RF Stage, PU and 2 Mic Inputs, Twin Baffled 12in Spkrs, Matched Red Line Transfs. **Mr. Keith, BX5061, or B0459 Q.V. Bldgs P.O.**

FOR SALE: At cost price or best, offer following brand new equipment still in manufacturers' packing prefer sell one lot but might separate; owner must sell; Axiom 150, Ldspkr £19/5/-; vented encl. mod. V.F.C. £19/5/-; Connoisseur Motor £33/15/-; G.P. 20 PU G.P. 19 LP Head £9/5/-; Prof. Built Hi Fi Ampl. Mod. S.W. £49/5/3; Ditto Williamson Tone Con. £36/12/-; Gram Cabinet £15; Sundries £5. **Street, 142 Phillip St., Sydney. BW8051.**

SELL: "H" Type Pathe 9.5 m.m. Camera and Portrait Lenses £23. 15 Chargers and Leather Case £8. Condition as new. **H. Smith, 52 Austin St., Footscray, Vic.**

SELL: Complete kit, including valves and KC5 tuning unit, R. & H. March, 1950, "Bandspread Six". What offers? 21 **Buruda St., Mayfield, 2N, NSW.**

SELL: Pyrox Tape Recorder, new. Disc Recorded, American Cutter, Sep. Playback Arm Radio Tuner 78 and 33 r.p.m. AT5 £9 TR1133 £8, RA10 £9 50 m.c. Tx. PW. Supplies. All Copies R.H. & QST. 1946 on. All Gear Good Order Must Sell. 28 **Bellevue Av., West Ryde. WL2382.**

SELL: R107 Receiver 3-Bands 1-18 Megs. B.F.O. Power Supply 100-250 V. A.C. and 12V. D.C Also, 80-90 Megs Converter £25. **M. Young, 8 Asquith St., Box Hill, Melb. Phone WX5309.**

WANTED: Driver Units and P.A. Horns. Also two Garrad Phono Units. Reply **Box 6 P.O. Kensington, N.S.W.**

WANTED: I would like to contact someone who has a home recording unit. **T. Palmer, Rye Park.**

WANTED. R. & H., July, 1939, May, July, 1941. Please advise price. **Adamson, Brentnall St., Mosman Pk., Bris.**

SELL or Exchange: R. & H. Feb., 1944 to Dec., 51. Complete. Other magazines and tech. journals, also. What offers? **Scott, Myrtle St., Crows Nest. XB5063.**

WANTED: 2 Speed Recorder. FJ2134. **Browne, 4 Tucabia St., Coogee.**

Tapping Hammer

A HANDY, soft-faced hammer for removing dents from sheet metal and for light forming and planishing operations can be improvised by fitting an ordinary tack hammer with a rubber tip cut from a medicine-dropper bulb. Cut the rubber tip squarely off at a point about halfway from the rounded end. Then press a small pledget of cotton into the rounded tip to form a cushion and force the tip over the small poll of the hammer. If necessary, use adhesive or cellulose tape to hold the rubber tip firmly in place on the hammer.

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